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BREEDING BIOLOGY OF THE YELLOWBROWED LEAF WARBLER *PHYLLOSCOPUS INORNATUS* IN KASHMIR[1]

TREVOR PRICE[2] AND NITIN JAMDAR[3]

(With a plate and eight text-figures)

The yellowbrowed leaf warbler *Phylloscopus inornatus* is a small (6 g) warbler which breeds from the Urals to central China as far south as the Himalayas, and winters in India and south-east Asia (Dementiev and Gladkov 1968, Williamson 1974, Ali and Ripley 1983). One subspecies (*P. i. humei*) breeds abundantly in Kashmir (Hume and Oates 1889, Bates and Lowther 1952, Price and Jamdar 1990). The nest and eggs of the species have been described by several authors (Hume and Oates 1889, Bates and Lowther 1952, Dementiev and Gladkov 1968, Ali and Ripley 1983), but despite its abundance other aspects of its breeding biology are poorly known. In this paper we describe the breeding behaviour of the species based on a study over three summers (1985-1987) at one locality in Kashmir. We present information on general breeding behaviour, clutch and brood sizes, and factors affecting nest success.

Phylloscopus inornatus breeds 1-3 weeks earlier in the season than other species of *Phylloscopus* at this locality (Price and Jamdar in press) and often encounters harsh weather conditions during egg-laying and early incubation. We will use information on nesting and feeding behaviour to ask how this species is able to breed so early, and also consider the selective factors which may have favoured early breeding.

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STUDY AREA AND METHODS

Our study was conducted at the Overa Wildlife Sanctuary, a small (33 sq. km) reserve located near Pahalgam, Kashmir. A description of the habitats, location, and summer climate at the Sanctuary is given by Price and Jamdar (1990). We spent from May-July in each year 1985, 1986 and 1987, at the Sanctuary. In 1985 we first established a study area near the entrance to the Sanctuary in coniferous forest at an altitude of *c.* 2,500 m. In June that year we discovered *P. inornatus* breeding abundantly in the birch woods which grow above the coniferous forest and form the treeline (*c.* 3,300-3,500 m altitude). Subsequently we camped at about 3,300 m except during periods of inclement weather in May 1986 and May 1987. In 1985 we established a single study area (UP1). In 1986 and 1987 we also studied a second area (UP2), about 2 km distant from the first, with one of us based at each of the localities (Price and Jamdar 1990).

Breeding biology: Methods used varied from year to year, and differed between the two study areas. In 1985 we only discovered the breeding grounds when most birds were incubating clutches of eggs. We concentrated on finding nests and documenting nesting success. This was the main focus of the study at UP2 in 1986 and 1987, although many nests were monitored from the beginning of nest building. In

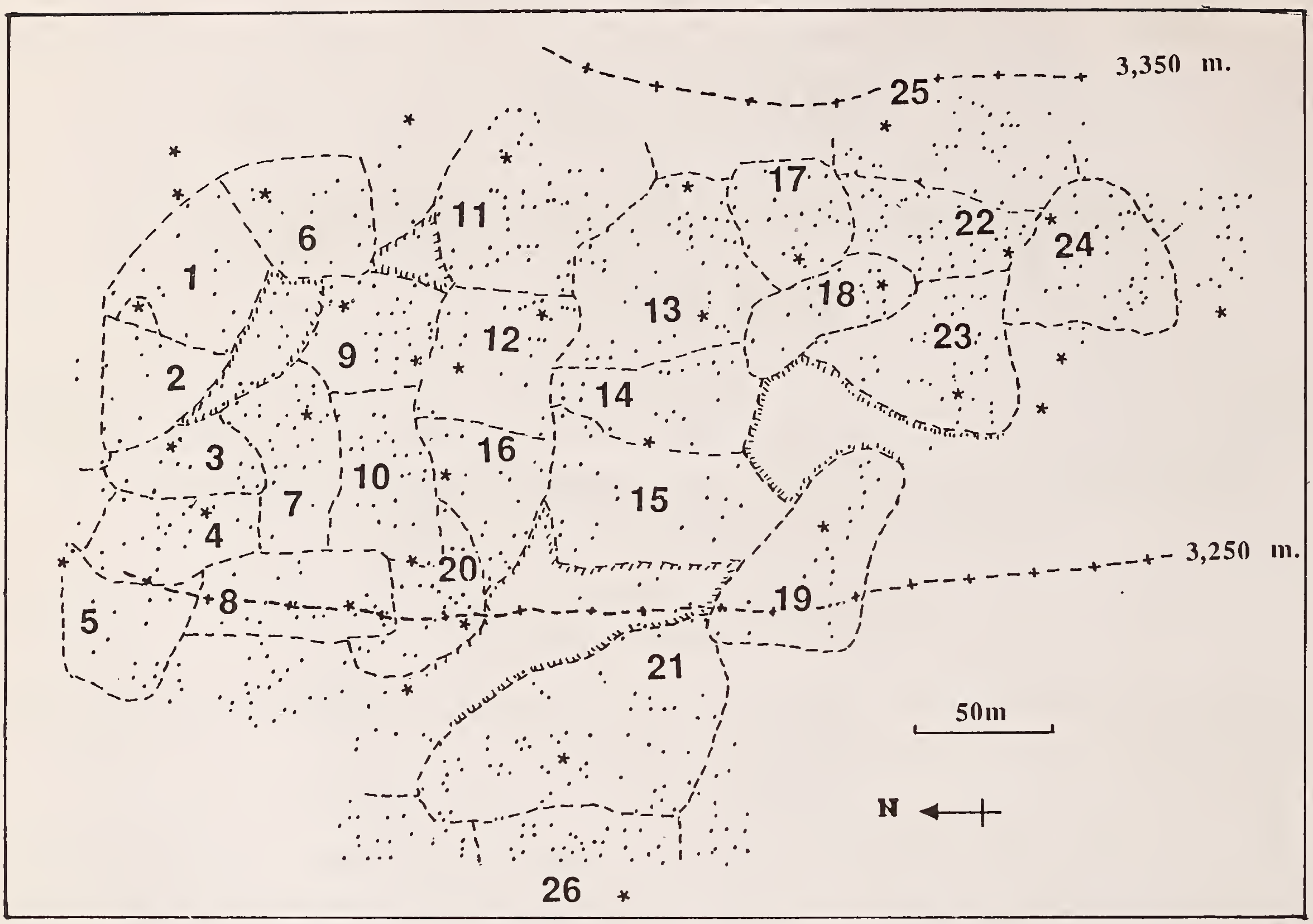


Fig. 1. Territories of *P. inornatus* over an area of birch woodland at UP1. Inwardly shaded areas mark areas that were apparently not defended. The woodland is continuous at the edges. Territory 17 was taken over by Male 13 expanding his territory on 18 June. Distances are measured along the ground: note from the contours (– +–) that the terrain is very steep. Each dot marks a mapped tree (>5m height). Nests are marked with an asterisk (*).

1986 at UP1, in addition to finding nests we made observations on courtship and feeding behaviour.

In 1987 at UP1 we trapped most of the males and females over a 10 ha. area prior to breeding. The birds were given a single metal ring and a single colour ring which enabled them to be subsequently individually identified. Then, during the pre-laying and incubation periods we mapped the territories of 24 males by intensively following them or watching individual trees and waiting for a male to sing in them (Fig. 1.) A male was considered to 'own' a tree if it was observed singing in it, and we never recorded two males singing in the same tree, except when one male was in the process of usurping the territory of another.

With the territories mapped we were able to search for a nest for every territory. At UP2 and in other years at UP1 we were unsure of nest density, and made no special effort to locate all the nests in a given area. All trees in the area covered by the mapped territories at UP1 were themselves mapped using a tape and compass, and individually marked with numbered metal tags.

We discovered a total of 349 nests over the 3 years of the study, mostly by watching the females carrying nest material during building and going on to the nest during incubation, and both parents when feeding the young. Nests were marked with a piece of flagging tape (red in the first two years; subsequently, when we realised crows were recognising the tapes and preying on nests, a very small green piece some distance away from the nests). Nests were checked infrequently to determine clutch and brood sizes and hatching and fledging dates. Chicks were ringed with a single numbered metal ring and weighed and measured approximately 11 days after hatching.

In connection with a separate study (Price in

prep.) hatchling chicks from many broods in 1986 and 1987 were exchanged between nests. Between one and three chicks were removed from one nest on the day of hatching, and placed in a second nest, with a corresponding number from the second nest placed in the first. In cases where this manipulation could have affected the results we report in this paper, we analysed the data separately for all broods, and for the subsection of broods which went unmanipulated.

Feeding behaviour: *P. inornatus* is entirely insectivorous. Feeding behaviour was recorded whenever possible. Since it is difficult to keep birds in sight for long, particularly in June and July when the birch trees are in leaf, quantitative observations were largely confined to recording a single feeding event for one individual, and then searching for another individual. We distinguished between four different feeding methods: 1. *Flycatch:* when a bird captures a flying insect, often one it has disturbed. 2. *Flypick:* when a bird captures an insect from a leaf or branch by flying for it. 3. *Hoverpick:* when the bird hovers in front of a leaf before picking up the insect. 4. *Standpick*: when a bird picks up an insect from the substrate without flying. We also recorded the size and type of prey whenever it was visible.

Arthropod abundance: Seasonal changes in arthropod abundance were quantified in two ways. First, we placed white bowls (*c*. 20 cm in diameter) half filled with water and detergent for periods of 1-6 days at selected locations in the study area. All arthropods which fell into the bowls were counted and sorted by size class and order. Second, we regularly beat birch branches with a stick, and collected all arthropods which fell into a tray held below the branch. A single sample usually consisted of the arthropods collected from 20 beats on a total of 6-15 birch trees in a small area.

Results

Distribution of *P. inornatus:* The breeding of *P. inornatus* appears to be intimately associated with the presence of broad leaf trees, particularly the silver birch *Betula utilis*. In pure birch stands above 3,300 m it occurs abundantly, in densities as high as 4 pairs per ha. in some areas (Fig. 1). It is by far the commonest breeding bird in the birch woods (Price and Jamdar 1990). It does not breed in, or along the edge of, the coniferous woods found between about 2,400 m and 3,300 m (contra statements of Bates and Lowther 1952, Williamson 1974).

A few pairs may breed in the stands of deciduous trees (notably walnut *Juglans regia*, cherry *Prunus cornuta*, and chestnut *Aesculus indica*) found along the rivers and around the villages at lower altitudes (Hume and Oates 1889). Our evidence in support of this is not conclusive: it is based on the presence of singing males throughout the day early in the breeding season (although they were not noted on our few visits to this altitude in June), and observations of a parent feeding a recently fledged juvenile at that altitude in July 1985.

Songs and call notes: As a prelude to describing the breeding behaviour we first classify the various vocalisations of this species. There are two distinctive songs (Martens 1980 gives sonagrams). The first song is a double noted *dioo dioo*, and the second a thin declining buzz, lasting about one second. The songs are used in different contexts. The first song is used commonly in territorial defence and advertisement: it is, for example, essentially the only song heard in the dawn chorus. The buzz is heard 1) at the end of some sequences of the first song, particularly when the female is nearby, 2) in rain and at dusk early in the season, and 3) after nests have been predated, or the female has disappeared. Both songs are also used in winter quarters; their significance in the non-breeding season merits a detailed investigation.

In addition to the songs there are a number of call notes in the breeding season. The commonest is a single alarm note, *dioo*, similar to one syllable of the first song, uttered by both sexes. A run-together version of rapid repeats of the alarm note is heard whenever avian predators or cuckoos fly over, given most often by the males during the early phases of the nesting period. Birds in the neighbourhood take cover, and nearby males take up the alarm call. The female has a *wheet wheet* call that she often utters when leaving a nest under construction, or when faced by a male who is not her mate. Finally both sexes 'chupper', a series of soft notes given between the pair when they are in close proximity, and the female is about to go to the nest. It appears to be a form of appeasement and it is uttered continuously during sex chases (chases of the female by the male over the territory). Chuppering also rarely occurs during male-male interactions.

Territory establishment: Males were found singing on territory from the time we arrived at the study area in early May 1986 and 1987. Initial territory establishment thus probably occurred before our arrival. In both years, several feet of snow were on the ground and the birch trees did not come into leaf until June. On most days males were present only in the early morning and deserted the area, apparently for lower altitudes, within a few hours after dawn. Individuals were only rarely seen in the afternoon. In May of both years there were days with rain, hail, and snow storms and temperatures near freezing (Price and Jamdar 1990). In these periods of inclement weather no *P. inornatus* individuals were present throughout the day.

We have not knowingly observed either initial territory establishment or initial pair formation. Prior to earnest nest building, and in the first hour or so after dawn, females are commonly seen visiting bare patches of ground, investigating suitable hollows, and occasionally picking up items of potential nest material. Males join their females and commonly may engage in long sex chases. The males also spend time off territory. Both females and males were seen to chase off intruding conspecifics. Wing flicking is common, and wing drooping in concert with the song also occurs, but most of the displays appear quite simple. The slow flutter flights recorded commonly in *Phylloscopus trochilus* in Europe (May 1949) were observed only once, and there is no elaborate wing waving as occurs in *P. occipitalis*. When agitated, for example by playback of tape recorded song, the male droops and shivers his wings and cocks his tail.

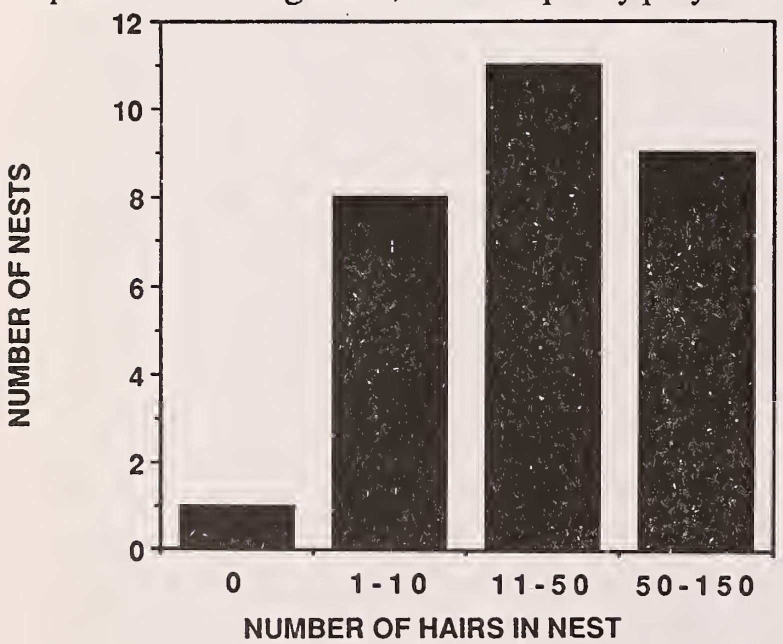


Fig. 2. Distribution of the number of mammal hairs in nests of *P. inornatus* (N = 25 carefully checked nests).

TABLE 1
LOCATIONS OF THE NESTS OF *P. inornatus*

Proportion on:	
Ledge*	38%
Slope	62%
Proportion in shade of[1]:	
Birch	49%
Fir	11%
Juniper	6%
Rhododendron	9%
No shade tree	25%
Dominant nearby vegetation[2]:	
Grass	60%
Bush	23%
Leaf Litter	17%

Based on N = 47 nests at UP1 in 1987. *A ledge is defined as the presence of a rockface below the nest within 0.5 m. [1]A tree is defined as shading the nest if its canopy lies vertically above the nest. [2]Vegetation within 50-100 cm of the nest.

We witnessed few fights. The most serious occurred at a time when most pairs were in the incubation phase. An individual expanded his territory, and expelled a neighbour. He was first observed in several close chases with the neighbour, before engaging in a full fight. We never observed the male feeding his mate.

Copulation is secretive: we only observed it on two occasions on 9 June, 1986, in a birch tree. Copulation was preceded by a long sex chase, with both birds of the pair wing flicking and holding their tails slightly cocked when perched. Adjoining pairs were excited at this time, and there was a great deal of interaction among neighbouring individuals, although the sexes could not be readily distinguished.

Territory characteristics: Fig. 1 shows a territory map for an area at UP1. Despite intensive watches a few areas were never seen to be visited by singing males. One or two other areas (notably a large part of the area covered by male 21) were only seen to be visited by the male once, and may not have been actively defended. The average territory area, as measured directly from this map is $2,030 \pm 806$ sq. m which is smaller than the size recorded for European *Phylloscopus* (Edington and Edington 1972, Lawn 1982, Tiainen 1983, Temrin *et al.* 1984), and the average territory contains 21 ± 11.6 trees. Approximately 20% of the trees in the area are conifers (Price and Jamdar 1990). Although territories may contain none or many conifers, they always

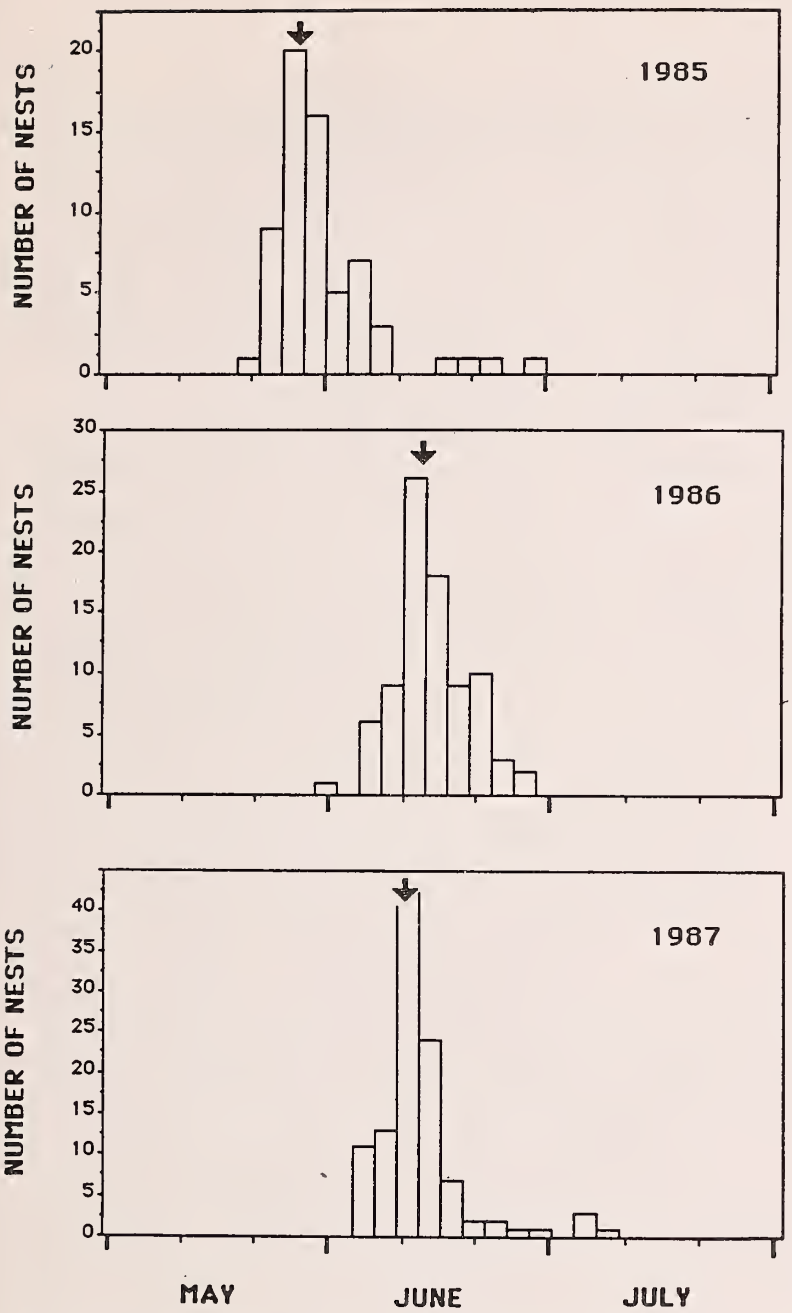


Fig. 3. Date of first eggs in nests in each of the three years of study. When clutch initiations were not observed the initiation date was back calculated from hatching or fledging date assumming 1) eggs are laid consecutively 2) a 16 day incubation period from the laying of the last egg and 3) 12 days to fledging. The incubation period used is shorter than the median incubation period for known nests (19 days), but distributions of accurately known clutch initiation dates in 1986 and 1987 were similar to those presented here. Few initiation dates were known in 1985.

contain at least one birch tree. Pure conifer stands are not occupied. We have never found an exception to this either in other years or at the other site.

Breeding system: The breeding system is largely monogamy. All 24 males in the mapped area of 1987 were known to have a mate, and at least two were known to be bigamous. Since it is difficult to be sure that all nests were found it is possible that there were more bigamous pairings. Laying dates of the two females in each of the two bigamous pairings were 1 day and 9 days apart. Unfortunately, three of the four nests in the bigamous pairings were predated prior to hatching, so it was not possible to ascertain the males' roles in raising the young. In two European species of *Phylloscopus* warbler *P. trochilus* and *P. sibilatrix*, males are known to set up secondary territories once their female is incubating, and may attract a second mate (Lawn 1982, Temrin 1984, Temrin *et al.* 1984). We have no evidence for such poly-territoriality in *P. inornatus* and on the basis of extensive observations think it unlikely. In our study both bigamous males attracted two females to one territory, as is known to occur in *P. trochilus* (Lawn 1982, Tiainen 1983) and in a third *Phylloscopus* species, *P. collybita* (Schonfeld 1978).

Nest building and nest characteristics: The nest is domed. As in other species of *Phylloscopus* only the female builds, although we suspected the male of picking up a stick on one occasion; nest building by both sexes has been observed rarely in other *Phylloscopus* (May 1949; Kovshar and Gavrilov 1974, Merton 1986, Radford 1986). On the first moderately warm day nest building begins in earnest. This occurred on 26 May 1986 and 30 May 1987 but must have occurred at least two weeks earlier in 1985. Nest building halts in bad weather. Of the 349 nests located all have been built on the ground or on a cliff face. In Table 1 we present an analysis of the nest locations for the birds in and around the territories of Fig. 1. Nests are often found concealed among the broad leaf perennial plant *Bergenia straychi*, particularly at UP2 where it is common. Three of the nests we found in 1986 were reused in 1987.

Characteristics of some nests were measured at the end of the 1987 breeding season. Average weight was 17.1 ± 4.0 g, range 12-25.5 g (N=38), weight may be overestimated for some nests because of water absorption. Average external width was 115 ± 13 cm and average external height 101 ± 11 cm (N = 33). The major constituent of the nest is grass. In addition 72% contained some birch bark, and 79% contained some moss (N=33). Pine needles were recorded in some other nests. A remarkable feature of these nests is their lining which, as Hume and Oates (1889), noted consists of thin grass and often mammal hairs (Fig. 2), but never feathers. The hairs in our nests were long and grey. Hume and Oates suggest the hair may come from horse or musk deer *Moschus moschiferus*, but neither of these species were observed in the vicinity of UP1 (al-

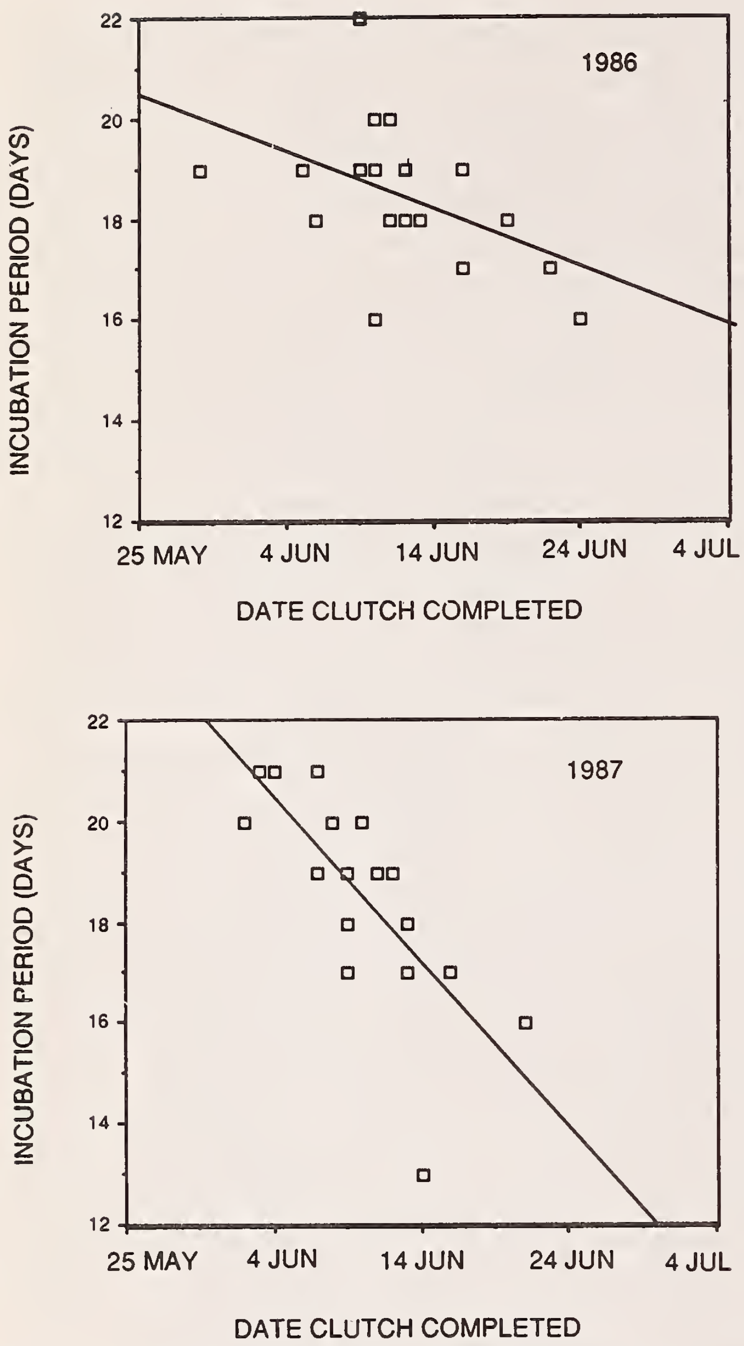


Fig. 4. Association between incubation period (number of days between clutch completion and hatching) with day of laying in the season. Linear regression lines are shown. The slopes are, for 1986: $b = -0.11$: $F(1,16) = 5$, $P<0.05$, for 1987: $b = -0.33$; $F(1, 18) = 24$, $P<0.001$.

though both these mammals and goats and cows were at UP2, where the nests were not examined in detail). One female at UP2 was seen flying a long distance into cow pasture to collect hairs. The Himalayan langur *Presbytis entellus* is common at both study areas, and may provide some of the hairs.

Laying and incubation: We found some nests as they were just beginning to be built, and from this can ascertain the interval between construction and laying. The longest recorded interval between commencement of building and laying was 16 days (30 May 1987, when the nest was well under construction, to 14 June). The interval varies and another female building a nest at the same stage on the same day laid her first egg on 5 June. The shortest recorded interval between depositing the first straw and laying was 5 days (17-22 June). This female had deserted her first nest after interference with her mate from a neighbouring male (see Fig. 1 caption), and built the new nest very rapidly.

The date of laying the first egg varied among females by more than 30 days in each year, although the bulk of the initiations occurred within 20 days of each other (Fig. 3). Later initiations may reflect relaying after early predation or desertion for other reasons. The median initiation date was 27 May 1985, 13 June 1986 and 10 June 1987. Initiation was therefore about two weeks earlier in 1985 than in the other two years. This presumably was in response to the better weather, and less standing snow in that year (Price and Jamdar 1990).

We visited five nests twice during the laying phase. In all of these nests eggs were laid on consecutive days. Incubation appeared to begin with the last egg, and eggs hatched within a day of each other. The earliest breeding females may continue to vacate the study area during the laying period, and only visit the nest and vicinity in the early morning to lay an egg. On 1 June, 1986 we watched a nest containing three eggs for 30 minutes at dusk and saw no sign of the pair. The female was observed arriving the next day after dawn to lay a fourth egg.

Incubation is entirely by the female. The presence of a brood patch was a definitive way to sex a bird in the hand as female, and observations on colour ringed birds confirm that the male never enters the nest. Once incubation begins both the female and male appear to reside on territory. However, in severe rain or hail, at least during early incubation, all birds may vacate the area for periods of at least 36 hours. We discovered this in 1986 when females left their nests for possibly as long as two days following rainfall on 12 June. One clutch was known to have been deserted for at least 12 hours, after it had been incubated for five days. The female returned and the eggs eventually hatched. In 1987, following heavy rain on the 8th through the 9th June, all incubating females left their nests. Nest temperatures were measured at two nests at 1300 hrs on 9 June by placing a wire thermocouple among the eggs, and allowing the temperature to equilibrate for

TABLE 2
THE PERCENTAGE OF NESTS IN EACH YEAR WHICH HAD 1,2,3,4, OR 5 EGGS WHEN THE CLUTCH WAS APPARENTLY COMPLETE

Clutch size (eggs)	Year 1985	1986	1987
1	0	3	2
2	0	3	8
3	11	25	16
4	63	66	70
5	26	2	4
Total number of nests studied	46	88	119

two minutes. Temperatures were 9° C in both nests. Ground temperature around the nest was 11°C, and air temperature 12°C. The nests were clearly not being incubated despite the fact that incubation had gone on for 3 days previously in each case. All females subsequently returned to the area, after at least two nights and one day away, and there was high hatching success in nests that were not predated.

Incubation periods vary greatly, from a minimum of 13 days to a maximum of 22 days (combining 1986 and 1987, X = 18.6 days ± 1.75 , N = 37). The length of the incubation period was significantly negatively correlated with clutch initiation date in both 1986 and 1987 (Fig. 4). A nest that was started ten days later on average took one day less to incubate in 1986, and three days less in 1987 (Fig. 4). The negative correlation of incubation period with laying date presumably reflects the increasing ability of females to continuously incubate eggs as the season progresses, and the weather improves.

Clutch sizes: Clutch sizes ranged from 1-5 eggs, but 1 and 2 egg clutches were rare. No single egg clutches hatched, but at least one was known to be incubated for several days. The distribution of clutch sizes varied among years (Table 2). The average clutch size was 4.2 ± 0.6 in 1985, 3.6 ± 0.8 in 1986, and 3.7±0.8 in 1987. Differences among years were significant (considering only the 3, 4 and 5 egg clutches, χ^2 = 28.3, degrees of freedom = 4, P< 0.001), with larger clutches being laid in 1985. In 1986 there was a negative association between clutch size and date of laying in the season (Table 3), but in 1985 and 1987 there was no significant trend. Some of the later-laid small clutches may be repeat clutches after early predation events, although we have no direct evidence for this.

Nestling period: At first the nestlings appear to be largely fed by the male, and the female spends most of her time incubating the young. As the young increase in size the female increases her share, until both sexes appear to be providing food equally, although we made no quantitative observations. Females continue to brood the young at night until they are close to fledging (this is based on an observation of a female entering the nest at dusk, and staying in, and the discovery of adult remains in a nest with 10 day old chicks, probably predated by the Himalayan weasel *Mustela sibirica*. We have recorded fledging at 11-14 days of age but the range may be greater.

Chicks hatch at approximately 0.9 g weight (N=13 chicks weighed on day of hatching in 1986). At time of ringing (i.e. at age *c.* 11 days) the average weight was 7.0 ± 0.7 g (N = 169) in 1985, 7.1 ± 0.7 g (N=171) in 1986, and 7.3 ± 0.6 g (N = 135) in 1987. Unlike the European *Phylloscopus* which appear to grow only to adult size (Tiainen 1978), chicks at ringing are *c.* 15% larger than adult weight. There was significant variation in weight among the three years, ANOVA, F(2,472)=9.9, P< 0.001, with the

TABLE 3
AVERAGE LAYING DATE FOR CLUTCHES OF DIFFERENT SIZES IN EACH YEAR

	Laying date 1985 X ± S.D. (N)	1986 X ± S.D. (N)	1987 X ± S.D. (N)
Clutch Size			
3 eggs	29 May ± 5 (5)	16 June ± 5 (15)	12 June ± 5 (17)
4 eggs	31 May ± 8 (26)	13 June ± 5 (53)	11 June ± 5 (65)
5 eggs	1 June ± 10 (12)	9 June ± 1 (2)	9 June ± 4 (4)
F value	0.3	3.7 *	0.5

Average date, standard deviation (in days) and sample size are given. When unknown, laying date was back calculated as in Fig. 3. The F values are for one way analyses of variance among clutch sizes. *P < 0.05.

TABLE 4
AVERAGE NUMBER OF EGGS IN A CLUTCH, NUMBER OF HATCHLINGS, AND NUMBER OF FLEDGLINGS FOR EACH YEAR

	1985 X ± S.D. (N)	1986 X ± S.D. (N)	1987 X ± S.D. (N)
Clutch size	4.2 ± 0.6 (46)	3.6 ± 0.8 (88)	3.7 ± 0.8 (199)
Hatch size	3.9 ± 0.9 (39)	3.5 ± 0.7 (71)	3.2 ± 0.8 (87)
Fledge size (all broods)	3.9 ± 0.9 (50)	3.2 ± 0.9 (54)	3.0 ± 0.9 (44)
Fledge size (unmanipulated broods)	–	3.4 ± 0.8 (25)	2.8 ± 1.03 (12)

Mean, standard deviation and sample size are given. Localities are combined. Unmanipulated broods refer to those broods which did not not receive chicks from another nest, or donate chicks to a nest at the time of hatching (see methods). In 1985 all broods were unmanipulated.

lightest chicks in 1985, and the heaviest in 1987. Possibly this reflects the fact that brood sizes were smallest in 1987, and largest in 1985 (Table 4), and hence individual chicks could receive more food in 1987.

In 1985 and 1986, the weight of the chicks at ringing was lower later in the season than earlier, but there was no such trend in 1987 (Fig. 5). We noted several very late broods in which chicks had slow growth rates, and may have fledged significantly later. In the last nest to hatch in 1986 the chicks were abandoned by their parents at approximately 7 days of age, and subsequently starved.

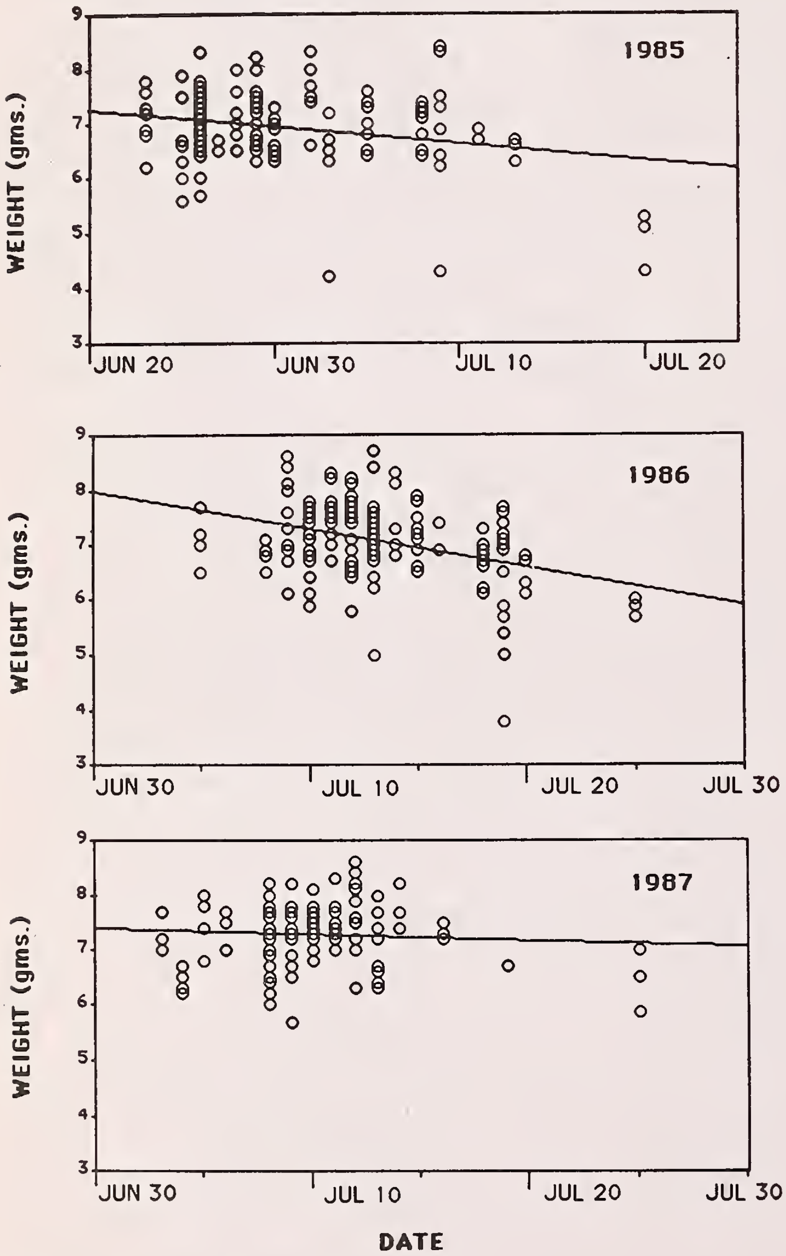


Fig. 5. Weights of chicks at fledging as a function of fledging date.

Hatching and fledging success: Hatchling and fledgling sizes for each year are shown in Table 4. On average there are fewer hatchlings per nest than eggs and fewer fledglings per nest than hatchlings. In 78 nests found prior to laying from which at least one chick hatched, 41% had fewer chicks hatching than eggs laid (some of these nests may have in fact lost a hatchling within a day or two of hatching). This is higher than the 10%-20% typically recorded for passerines (Lundberg 1985). In 155 nests checked at hatching, 52% had fewer chicks fledging than hatched. This figure may be inflated by the experimental manipulations we conducted (swapping hatchlings among nests). In 1985, when we conducted no manipulations, only 18% of the nests (N = 22) had fewer chicks at fledging than hatching. But in 1986 and 1987 brood reduction among unmanipulated broods was 48% (N = 43), similar to the value for all broods, so we conclude that experimental manipulation was not a major cause of brood reduction.

In addition to the loss of individual eggs and nestlings through hatching failure, starvation, etc., lower average fledge sizes than average clutch sizes per nest could be due to heavier predation rates on nests with larger broods, but we show below that there is no association of clutch or brood size with probability of predation (Table 6).

Fledging: Once chicks leave the nest some are fed by the male and some by the female, as commonly occurs in Passerines (McLaughlin and

TABLE 5
NESTING SUCCESS BY PERIOD AND LOCALITY

	Fate of nests					
	Successful fledging	Predated	Deserted	Not successful for other reasons	Unknown	Total
1985, UP1						
Nest found when:						
Building	1	0	0	0	0	1
Laying	1	0	0	0	0	1
Incubation	24	5	1	1	3	34
Young chicks	13	3	0	2	0	18
Old chicks	13	1	0	0	0	14
Total	52	9	1	3	3	68
1986, UP1						
Nest found when:						
Building*	4	14	10 (8)	3	0	31
Laying	1	0	0	1	0	2
Incubation	5	4	1	0	0	10
Young chicks	3	3	0	0	0	6
Old chicks	2	0	0	0	0	2
Total	15	21	11	4	0	51
1986, UP2						
Nest found when:						
Building*	19	2	14(11)	2	4	41
Laying	1	0	0	0	0	1
Incubation	16	7	2	2	0	27
Young chicks	3	2	0	0	0	5
Old chicks	2	1	0	0	0	3
Total	41	12	16	4	4	77
1987, UP1						
Nest found when:						
Building*	13	8	6(4)	1	1	29
Laying	3	1	1	0	0	5
Incubration	8	7	1	1	0	17
Young chicks	0	3	0	0	0	3
Old chicks	1	0	0	0	0	1
Total	25	19	8	2	1	55
1987, UP2						
Nest found when:						
Building	6	32	10 (8)	1	3	52
Laying	2	3	0	0	0	5
Incubation	9	16	3	0	0	28
Young chicks	2	11	0	0	0	13
OOld chicks	0	0	0	0	0	0
Total	19	62	13	1	3	98

In entries refer to number of nests. The locality UP 2 was not studied in 1985. *In the deserted column the number of nests deserted

Montgomerie 1985). They spend much time sitting, mainly in birch trees, and have a weak *sip* contact call with the parents. They may be led quite far from the natal territory within a few days (we have several records of chicks in association with one or other parent >100 m from territory). Most individuals leave the area within one week of fledging, and only a few independent juveniles and adults were present at these altitudes by mid-July of any year.

Table 6
ASSOCIATION OF BROOD SIZE AT HATCHING WITH PROBABILITY OF PREDATION

	Brood size (hatchlings)					
	1985		1986 UP2		1987 UP1	
	<3	>4	<3	>4	<3	>4
Proportion predated	13%	17%	24%	21%	43%	43%
Total number of nests	32	29	25	28	30	14

For each session there was no significant difference in the proportion of nests predated (χ^2 tests), when comparing the two brood size categories.

Table 7
ASSOCIATION OF PROBABILITY OF PREDATION WITH LAYING DATE IN THE SEASON

	1985		1986 UP2		1987 UP1	
	Predated	Successful[a]	Predated	Successful	Predated	Successful
Average first egg date	27 May	29 May	11 June	13 June	11 June	11 June
Sample size	8	52	9	39	18	25

When unknown, laying date was back calculated as in Fig. 3. There was no significant difference between the laying date of predated and successful nests in any of the three comparisons (t. tests).

Factors Affecting Nesting Success

An analysis of whole-brood nesting success is presented in Table 5, separately for each year and area. Predation was often accompanied by the pulling off of the roof or pulling the whole nest out of its socket. Predation was also assumed when the nest was found empty but intact, but in some of these cases the nest may have failed due to starvation of the chicks. Desertions at the egg or nestling stage were assumed when the contents remained. They may have included loss of adults due to mortality. Two other deserted nests containing dead young may have been destroyed by heavy rainfall. Many nests were abandoned during building, and a replacement built nearby: these are listed as desertions in Table 5.

Predation and food availability have been identified as the major factors influencing nesting success and the number of chicks that can be raised to independence (Lack 1968, Lundberg 1985, Lima 1987, Martin 1987). We consider the possible influence of each in turn on the nesting success and timing of breeding of *P. inornatus*.

Predation: Predation rates were sometimes extremely high, and there is little doubt that they were increased by our activity. This was particularly evident at UP1 in 1986 when 64% (N = 28) of all nests found during the building or egg stage were predated, and at UP2 in 1987 when 75% (N = 68) were predated. In both of these study sessions we naively marked the nests we found with red flagging tape, and it appears that the jungle crow *Corvus macrohynchos*, and possibly the Himalayan nutcracker *Nucifraga caryocatactes* learnt to associate the tape with the nest. Because of the unnaturally high predation rates in these two study sessions we do not include them in analyses of factors affecting predation. Corresponding predation rates for the other study sessions were in 1985 at UP1: 16% (N = 31), in 1986 at UP2: 20% (N = 45), and in 1987 at UP1: 40% (N = 40).

Since many nests were found well into incubation, particularly in 1985, predation rates are likely to be generally higher than 20% over the whole breeding cycle (nests were marked with red tape in 1985 and in 1986 at UP2, but apparently avian predators did not learn to associate the tapes with the nests). We examined variation in the placement of the nest to see if it affected predation probability. Variation in the proportion of nests predated at UP1 in 1987 was examined separately for each of the three classifications of nest location, as recorded in Table 1. In all cases we found no significant associations (χ^2 tests, $P > 0.3$ in each case).

Although crows were probably the major cause of predation, other natural predators are common. We have direct evidence or suspect the following: Himalayan weasel (based on the discovery of the adult parents' wings on or near two predated nests), brown bear *Ursus isabellinus* (based on observing the bear near a nest, and finding an uprooted sapling

beside the predated, and removed, nest), and Himalayan nutcracker (observed predating a nest with eggs). In addition the viper *Agkistrodon himalayanus* is common, and was observed preying on a *Phylloscopus occipitalis* nest in the area. Rodents such as mice and voles are possible egg predators, and a redflanked bush robin, *Erithacus cyanurus* was once seen actively chasing a mouse from its nest. Troops of up to 50 Himalayan langurs were seen near recently predated nests.

Predation risks and brood size: It has been suggested that larger broods may be subject to greater predation risk than smaller broods because the parents need to carry food to the young more often, thereby increasing the risk of attracting visual predators (Lack 1968, Lundberg 1985, Lima 1987). We examined this by comparing the proportion of predated nests which had three or fewer hatchlings with the proportion predated which had four or more nestlings, and found no significant difference (Table 6).

Predation risk and laying date: We showed previously that clutches laid earlier in the season take longer to hatch than those laid later. Early nests also appear more exposed, because much of the annual vegetation has still to grow. Early nests may therefore be subject to greater predation risk than those laid later. On the other hand, predation may be less intense earlier in the season, because of the reduced activity of predators, particularly snakes. We found no significant association between laying date and predation risk (Table 7).

Predation was usually manifested as the loss of whole clutches or broods. However, we noticed during routine nest checks that in at least five nests single eggs were being removed or lost through breakage, particularly at UP2 in 1987. In the nest which was most carefully monitored a three egg clutch was reduced to two eggs. The female continued to incubate, and these eggs hatched. We do not know the cause of these egg disappearances.

Replacement nests: Some nests which were predated during early incubation were replaced by second clutches, particularly at UP2 in 1987. On many occasions predation of nestlings is accompanied by complete disappearance of the pair within a few hours, presumably to lower altitudes to begin the moult (Williamson 1974). After some predation events just the female disappears from the area and the male stays on territory continuously singing the *buzz* song. One male was observed carrying food more than 24 hours after its nest had been predated. Most predation events do not appear to lead to the laying of second clutches, and we believe that no second broods are raised after a successful first brood in this population.

Diets and food availability: Late hatching broods often have underweight young (Fig. 5), and starvation was observed in the very last broods to hatch. This may be because late-breeding parents are themselves in poor condition and unable to provide sufficient food, but it may be because food supply is declining towards the end of the season. If this is the case, it could explain why *P. inornatus* breeds early in the season. In this section we assess the possibility by investigating the diet of *P. inornatus* and measures of arthropod availability.

An examination of faecal material and observations of foraging behaviour show that *P. inornatus* is entirely insectivorous. We were unable to quantify arthropod remains in the faeces, but identified Diptera, Coleoptera, Homoptera, Arachnida, and Lepidoptera larvae. Faeces of both adults and nestlings were full with fragments of chitinous appendages, and wings of small arthropods were also common, suggesting that much of the diet consists of adult insects, and the nymphs of hemimetabolous insects. Remains of caterpillars were rare in the faeces. Caterpillars were also rarely observed being eaten: we saw a caterpillar in the bill of the bird in only 2% of all point observations (N = 414).

Feeding techniques did not vary significantly among years or months (Fig. 6). Approximately two thirds of all feeding techniques were standpicks, and most of the remainder were flypicks. Flying insects were rarely captured. Arthropods were picked off branches and leaves, rarely from the trunk, ground, or snow. Most foraging occurs in birch trees, but the understorey willow *Salix denticulata* is commonly utilised, particularly early in the season before the birch is in leaf.

Seasonal changes in plant and arthropod abundance: In 1986 and 1987 leaves began to appear on the birch trees only at the end of May, and by mid-June most trees were in full leaf. In 1985 leaves appeared earlier, but we do not know when.

Changes in the abundance of arthropods captured in the water-detergent plates are shown in Fig.

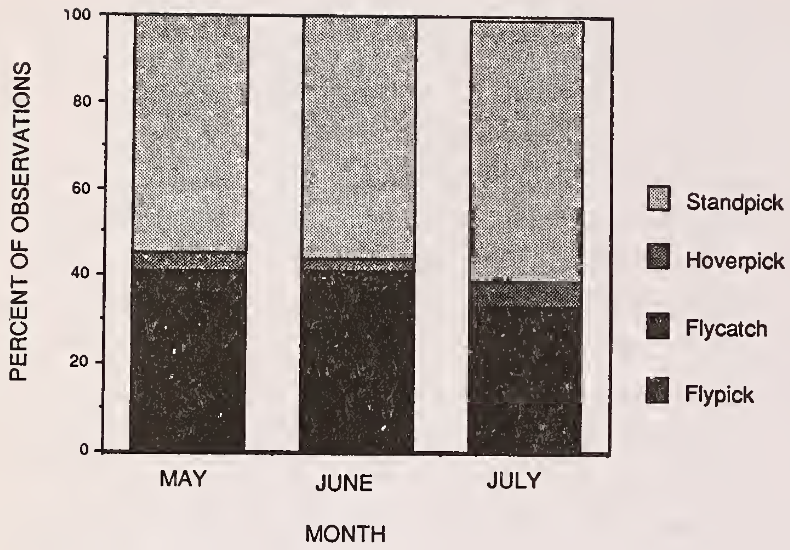


Fig. 6. Proportion of feeding techniques in each of four different categories. There was no significant variation among years (χ^2 tests), and the data were combined for all three years. Sample sizes are May: N = 201 observations, June: N = 135, July: N = 78. There was no significant difference among months in the proportion of foraging techniques used (χ^2 = 2.6, degrees of freedom = 6, P > 0.5)

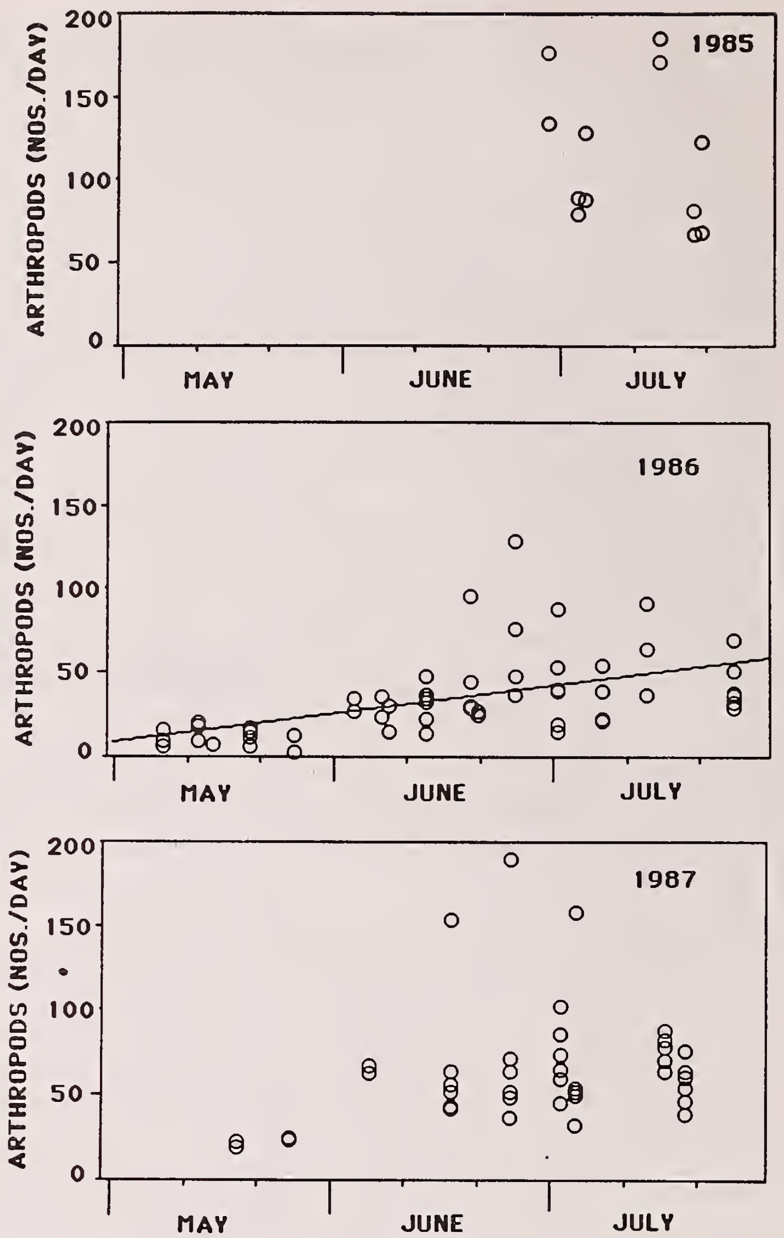


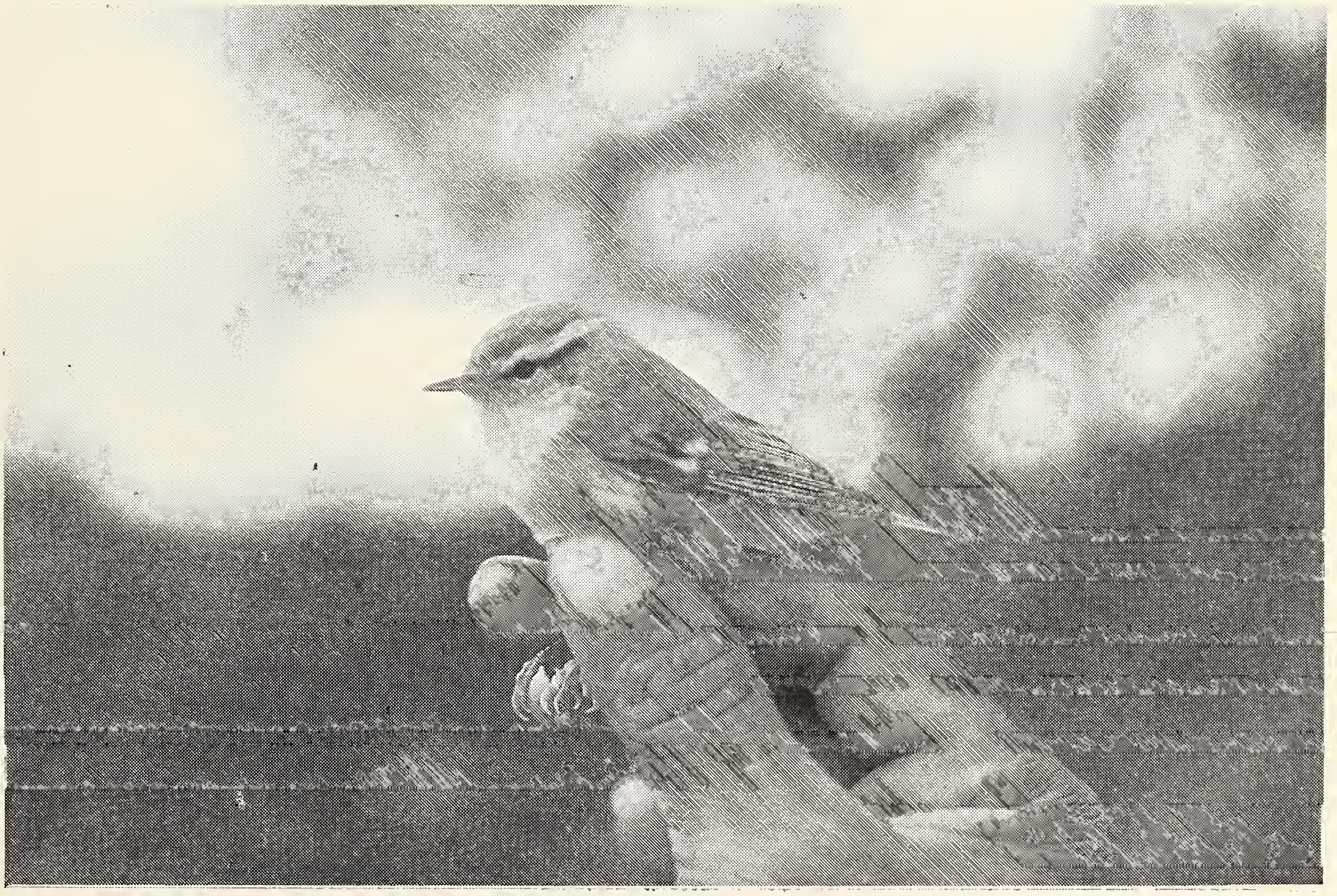
Fig. 7. Seasonal changes in Arthropods found in plates left out for periods of one-six days. Each point marks a single plate, on the day of collection. In 1986 there was a significant increase in abundance through the season, the slope of the linear regression line (shown) is b = 0.55 arthropods/day/day, F (1,56) = 21, P <. 001. In 1987 there was no significant linear increase in abundance, and in 1985 the plates were only put out towards the end of the season. See text for a discussion of curvilinearities in abundance.

7. Arthropod abundance appears to be lower in 1986 than the other two years but this is almost certainly an artifact, because the plates were left out for an average of 5.3 days in 1986, but only 1.0 and 1.3 days in 1985 and 1987 respectively. As the plates fill up they are probably less attractive to insects. The plates also occasionally overflowed due to rainfall, or dried out in 1986, but the extent to which this led to lss of insects is unclear (cases of drastic overflows or total drying out are not included in these analyses).

In 1986 there was an increase in arthropod abundance through the season (Fig. 7). There was also a trend towards more arthropods being present in the middle of the season than at the end, although the regression coefficient for the squared term in a second order polynomial regression of arthropod abundance on date was not significant (P = 0.1). In 1987 there was no significant linear increase through the season (Fig. 7) but there was a significant hump in arthropod abundance in the middle of the season (test as before, P<0.05). Thus the results from the plates suggest that flying arthropods tend to be most abundant during the hotter, clear days of June, and less abundant during the more cloudy days of July. The arthropod catch in the plates largely represents Diptera (flies constituted 91% and 96% of the catch in 1986 and 1987 respectively). When Diptera were excluded we found no linear trend in the 1986 season (P> 0.1) but a significant linear increase in catch through the 1987 season [F(1,39) = 5.3, P = 0.03]. When Diptera are excluded there is no hint of a maximum in arthropod abundance in mid-season.

That the possible mid-season maximum in arthropod abundance refers to flying arthropods (i.e., those airborne and able to land in the plates), and not to absolute arthropod abundance is suggested by the collections from the beats of birch

Above: Habitat of *Phylloscopus inornatus*
Below: *Phylloscopus inornatus*



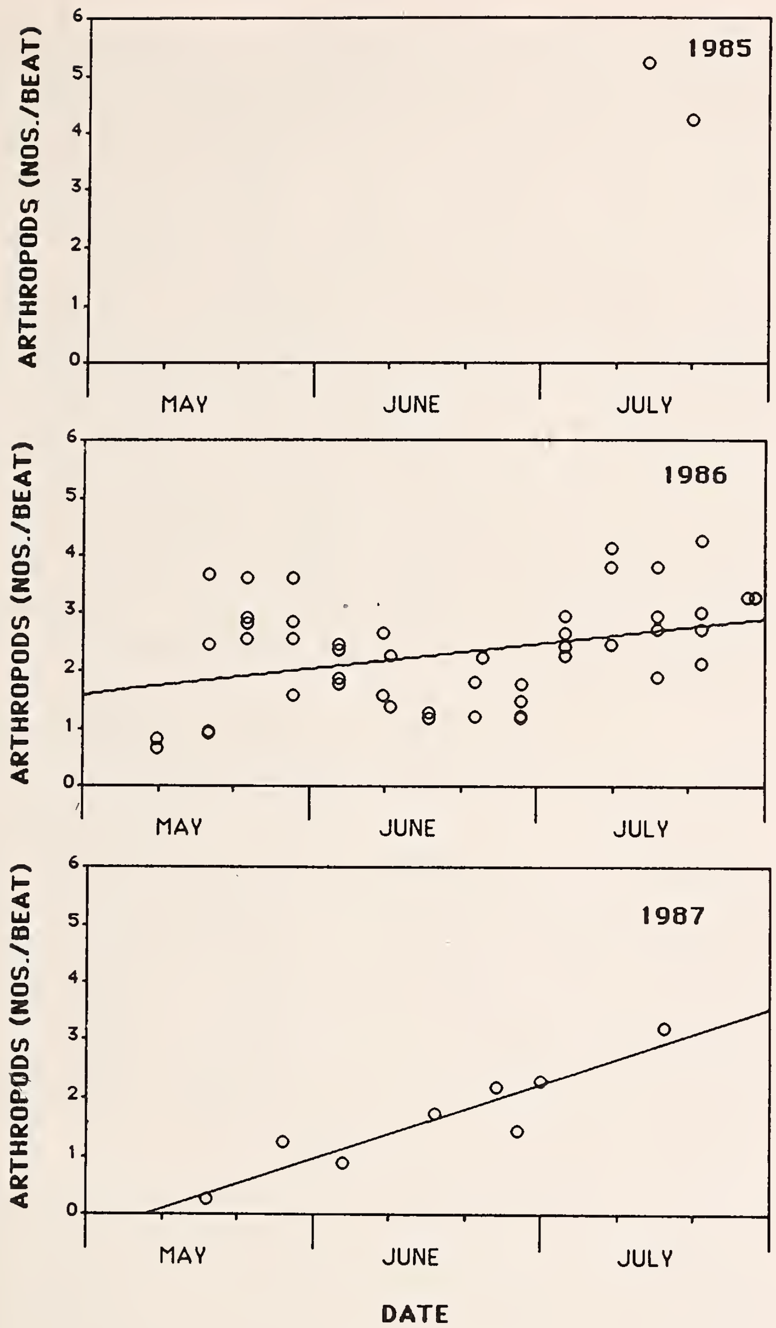


Fig. 8. Numbers of Arthropods falling on to a tray held below a birch branch hit sharply with a stick. Each point refers to the average collection from 20 (occasionally 30) branches in a restricted locality. Linear regression lines for 1986 and 1987 are shown, for which the slopes are
for 1986 b = 0.014 insects/beat/day, $F(1,48) = 7$, $P < 0.05$,
for 1987 b = 0.025 insects/beat/day, $F(1,6) = 34$, $P < 0.01$.

branches, which show no evidence of a mid-season maximum (Fig. 8). The proportion of Diptera in the beat collections was 52% in 1986 and 27% in 1987, with much of the remainder being Homoptera. In 1986 the number of arthropods caught by beating increased through the season, but there was an almost significant minimum in June (second order regression, test for the significance of the squared term, $P = 0.06$). This may reflect the fact that the insects would fly away on sunny days in June, rather than fall on to the tray. In 1987 there was a strong linear increase in arthropod abundance through the season (Fig. 8).

We conclude that arthropod abundance increases from May to July. This does not mean that arthropod availability to birds increases in the same way. As vegetation thickens insects may be more difficult to catch, particularly by flycatching, and there are suggestions that flying insects are in fact less available in July than June.

Returns Between Breeding Seasons

Our data on return rates are fragmentary, and cannot be used to infer survival rates. Of 8 females and 10 males breeding in the main study area at UP1 in 1985, one female (13%), and four males (40%) were recorded breeding there in subsequent years (the female and three of these males were recorded in both 1986 and 1987). Of 12 females and 12 males breeding in 1986 four females (33%) and four males (33%) were recorded in 1987. Survival is clearly higher because some birds will be missed, particularly if they disperse between breeding seasons. In many species individuals are more likely to disperse following nest failure (Harvey *et al.* 1979, Newton and Marquiss 1982), and nest failure was common at UP1 in 1986 (Table 5).

Out of 349 banded nestlings in 1985 and 1986 we have found six chicks subsequently breeding in or near the study area. In most bird species young of the year typically disperse further than adults (e.g. Harvey *et al.* 1979, Tiainen 1983).

Discussion

In comparison with species of European *Phylloscopus* warblers *P. inornatus* has a smaller clutch size and breeds at higher density (May 1949, Schonfeld 1978, Lawn 1982, Tiainen 1983). Food availability and/or predation intensity may explain differences in clutch size between Europe and Kashmir. In particular, European species have longer daylight hours in which to forage (Lack 1968). It is not clear that the high density of *P. inornatus* depresses absolute food abundance and affects the clutch size, because some apparent food sources are not exploited. First, several areas of birch trees do not appear to be actively defended or regularly visited (Fig. 1). Second, many conifer trees are not exploited at all, although conifers in territories are regularly visited for feeding.

Clutch size and other measures of reproductive success varied significantly among years. High reproductive success was found in 1985, in which the birds bred early. In a study of a population of *P. trochilus* in Finland Tiainen (1983) showed that the average clutch size decreased during the breeding season in any one year, and that inter-annual differences in clutch size could be largely attributed to differences in clutch initiation date among years. A similar explanation may hold for *P. inornatus*, although we found a significant decline in clutch size with laying date in only one year (1986).

The hypothesis is that females adjust their clutch size according to their condition and their ability to raise young, given the expected food supply at the nestling and fledgling stages (Perrins 1970). A prediction of this hypothesis is that food supply should be absolutely lower at similar stages of the breeding cycle in different years: this remains to be tested.

P. inornatus breeds early and builds its nest as soon as available ground is clear of snow. At times during early incubation there may be severe rain and hailstorms. Three possible adaptations to allow Passerine birds to breed in cold weather have been identified (Carey 1980). First, males may share incubation, although specific examples of this in extreme climates are not known. Second, males may feed the female on the nest, as occurs in crossbills (*Loxia* spp.) (Skutch 1976, Carey 1980). Third, females may leave the nest, and the eggs be able to withstand chilling. This occurs, for example, in North American flycatchers, although the eggs are chilled for a maximum of half an hour once incubation has begun (Morton and Smeraski 1985).

P. inornatus has taken this last adaptation to an extreme not previously recorded in Passerines, with females abandoning the nest, at least during early incubation, for more than 36 hours, during which time the eggs are close to ambient temperature (*c*.9°C). This desertion has no apparent effect on subsequent hatching success. Leaving eggs unattended prior to commencement of incubation is common among birds, but (apart from possible anecdotal examples) periods of extensive abandonment after incubation has begun have only been recorded in a few species of seabirds (Skutch 1976). The Manx shearwater *Puffinus puffinus* has been recorded leaving its eggs unattended for periods of up to seven days with no adverse effects on hatching success (Skutch 1976). In the fork-tailed storm petrel *Oceanodroma furcata* nests may be deserted for several days at a time, and incubation periods vary from 37 to 68 days (Boersma and Wheelwright 1979). These species are larger, and their burrows not as cold.

Typical variation in incubation period appears to be about 2 days for many passerines (Skutch 1976, Ricklefs and Smeraski 1983). Skutch (1976) records a maximum variation of 4 days in the incubation period among 88 Passerine species, with the exception of the red-winged starling *Onychognathus morio*, from the lowlands of South Africa, in which the incubation period varies from 12 to possibly longer than 23 days for unknown reasons (Rowan 1955).

The large variation in incubation period (from 12 to 22 days) in *P. inornatus* probably arises out of variation in the extent to which females can continuously cover the eggs, for incubation period is negatively correlated with laying date, and the earlier the laying the colder the conditions (minimum temperatures average approximately 10°C higher in June than May (Price and Jamdar 1990). Cold temperatures and inclement weather may also account for delays between nest construction and initial laying early in the season.

P. inornatus shows a number of other behaviours which appear to be related to its early breeding. It is possible that the placing of its nest on the ground enables greater insulation than would be the case in trees (Miller 1984), although lack of feathers in the nest reduces insulation properties (Tiainen *et al.* 1983). The species undergoes a diurnal altitudinal migration. Display, nest building, and even the laying of the clutch prior to incubation may occur only in the early hours of the morning, with the majority of the day (and night) spent at lower altitudes.

Our evidence for the diurnal migration is not direct: it is based on the absence of the species in the late morning and afternoons. In the early season there are no leaves on the birch trees and we believe it to be very unlikely that birds were foraging quietly and not noticed. *P. inornatus* individuals were seen at lower altitudes (below 2,800 m) at these times, and we once observed a male flying a long distance down the valley from the UP2 study area, at about 1000 hrs. Although these observations are

only suggestive, and detailed observations on marked birds are needed, similar migrations occur in other species. Several Passerine species are known to display on their subsequent nesting grounds in the morning, and feed elsewhere for the rest of the day (Rothstein *et al.* 1984).

We now turn to ask why *P. inornatus* breeds so early in the season. Other species of *Phylloscopus* in Kashmir breed on average 1-3 weeks later (Price and Jamdar in press). It is possible that the early breeding affects adult survival by allowing them to rapidly vacate the area. It seems more likely, however, that time of breeding arises out of selection on nesting success. Many attributes of nesting success, including clutch size and time of breeding, have been attributed to either the role of food availability for raising the nestlings, or predation pressure (Cody 1966, Lack 1968, Lundberg 1985, Lima 1987, Martin 1987).

We could find no association of predation intensity with time of breeding but there are some suggestions that food availability may affect nesting success, and the last chicks in the nest do appear to be short of food. There are problems with interpreting this as a result of declining food supply; late breeding adults may be in poor health and unable to efficiently raise the chicks (Price *et al.* 1988), or adults may desert their brood in order to vacate the breeding grounds and begin their moult. Nevertheless, food supply rather than predation risk appears to be the best explanation for the early breeding of *P. inornatus.*

Many of the patterns we observed were not consistent among years. For example, clutch size declined with laying date in one year only, and the weight of chicks at fledging declined through the season in just two of the three years. In addition average characteristics such as clutch and fledge size, and chick weights, varied significantly among years. The various adaptations of *P. inornatus* such as clutch size and timing of breeding will represent the integrated response to selection over many generations. The variation among years we have identified means that our conclusions must be tentative, and emphasizes the importance of long term field studies.

Summary

The breeding and feeding behaviour of the yellowbrowed leaf warbler *Phylloscopus inornatus* was studied from May to July over a three year period (1985-1987) in a birch wood at 3,300 m altitude in Kashmir, where the species occurs at high density (up to 4 pairs per hectare).

At the beginning of the season birds undergo a regular diurnal altitudinal migration, visiting the breeding grounds only in the early morning, for display and nest construction. Clutch sizes varied from 1-5 eggs, with the highest average clutch sizes occurring in the year 1985 when breeding was about two weeks earlier than the other years. The incubation period varies from 12-22 days and is negatively correlated with the date in the breeding season on which the clutch is laid. Early breeding females can leave the nest unattended for at least 36 hours when the weather is bad, during which time chick development is probably slowed or halted. The nestling period varies between 11 and at least 14 days.

The natural rate of predation on nests may be higher than 20%, but it is difficult to ascertain because of problems with human disturbance. Predation rates did not vary with time of breeding in the season. *P. inornatus* is entirely insectivorous. Although arthropod abundance increases through the season, availability of food may decline, and in two out of the three years chick weight at fledging was lowest for those chicks fledging at the end of the season. The early breeding of *P. inornatus* in comparison with other *Phylloscopus* species in the area may be a response to its food supply rather than predation, but more data is needed to distinguish among hypotheses.

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References

Ali, S. & Ripley, S.D. (1983): Handbook of the birds of India and Pakistan. Oxford University Press, Delhi.

Bates, R.S.P. & Lowther, E.H.N. (1952): Breeding birds of Kashmir. Oxford University Press, Delhi.

Boersma, P.D. & Wheelwright, N.T. (1979): Egg neglect in the procellariformes: reproductive adaptations in the fork-tailed storm-petrel. *Condor 81:* 157-165.

Carey, C. (1980): The ecology of avian incubation. *Bioscience 30:* 819-824.

Cody, C. (1966): A general theory of clutch size. *Evolution 20:* 174-184.

Dementiev, G.P. & Gladkov, N.A. (1968): Birds of the Soviet Union. 6. English edition. Israel Program for Scientific Translations.

Edington, J.M. & Edington, M.A. (1972): Spatial patterns and habitat partitioning in the breeding birds of an upland wood. *J. Anim. Ecol. 41:* 331-357.

Harvey, P.H., Greenwood, P.J. & Perrins, C.M. (1979): Breeding area fidelity of the Great tit (*Parus major*). *J. Anim. Ecol. 48:* 305-313.

Hume, A.O. & Oates, E.W. (1889): The nests and eggs of Indian Birds. 2nd edition. Vol. 1. Porter, London.

Kovshar, A.F. & Gavrilov, E.I. (1974): On the biology of the Olivaceous leaf warbler of the Tian-shan Mountains. *J. Bombay nat. Hist. Soc. 71:* 367-375.

Lack, D. (1968): Ecological adaptations for breeding in birds. Methuen, London.

Lawn, M.R. (1982): Pairing systems and site tenacity of the Willow Warbler *Phylloscopus trochilus* in southern England. *Ornis Scand. 13:* 193-199.

Lima, S.L. (1987): Clutch size in birds: a predation perspective. *Ecology 68:* 1062-1070.

Lundberg, S. (1985): The importance of egg hatchability and nest predation in clutch size evolution in altricial birds. *Oikos 45:* 110-117.

Martens, J. (1980): Lautausserungen, verwandtschaftliche Beziehungen und Verbreitungsgeschichte asiatischer Laubsanger (Phylloscopus). Fortschritte der Verhaltensforschung No. 22.

Martin, T.E. (1987): Food as a limit on breeding birds: a life history perspective. *Ann. Rev. Ecol. Syst. 18:* 453-487.

May, D.J. (1949): Studies on a community of willow warblers. *Ibis 91:* 24-54.

McLaughlin, R.L. & Montgomerie, R.D. (1985): Brood division by Lapland Longspurs. *Auk 102:* 687-695.

Merton, R. (1986): Rapid territory establishment by a wood warbler. *Ringing and Migration 7:* 56.

Miller, A.P. (1984): On the use of feathers in birds' nests: predations and tests. *Ornis Scand. 15:* 38-42.

Morton, M.L. & Smeraski, C.A. (1985): The regulation of egg temperatures and attentiveness patterns in the dusky flycatcher (*Empidonax oberholseri*). *Auk 57:* 499-513.

Newton, I. & Marquiss, M. (1982): Fidelity to breeding site and mate in the sparrowhawk *Accipter nisus*. *J. Ecol. 5:* 305-313.

Perrins, C.M. (1970): The timing of birds' breeding seasons. *Ibis 112:* 242-255.

Price, T. & Jamdar, N. (1990): The breeding birds of Overa Wildlife Sanctuary, Kashmir. *J. Bombay nat. Hist. Soc. 87 (1):* 1-15.

Price, T. & Jamdar, N (in press): Breeding birds of eight sympatric species of *Phylloscopus warblers* in Kashmir. *J. Bombay nat. Hist. Soc.*

Price, T. & Kirkpatrick, M. & Arnold, J. (1988): Directional selection and the evolution of breeding date in birds. *Science 24:* 798-799.

Radford, A.P. (1986): Nest building by male Wood warbler. *British Birds 79:* 137.

Ricklefs, R.F. & Smeraski, C.A. (1983): Variation in incubation period within a population of the European Starling. *Auk 100:* 926-931.

Rothstein, S.I. & Verner, J. & Stevens, E. (1984): Radio-tracking confirms a unique diurnal pattern of spatial occurrence in the parasitic Brown-headed cowbird. *Ecology 65:* 77-88.

Rowan, M.K. (1955): The breeding biology of the Redwinged Starling *Onychognathus morio*. *Ibis 7:* 663-705.

Schonfeld, M. (1978): Der Weidenlaubsanger. A. Ziemsen Verlag, Wittenberg Lutherstadt.

Skutch, A.F. (1976): Parent birds and their young. University of Texas Press. Austin, Texas.

Temrin, H. (1984): Why are some Wood Warbler (*Phylloscopus sibilatrix*) males polyterritorial? *Ann Zool. Fennici 21:* 243-247.

Temrin, H., Mallner, Y. & Winden, M. (1984): Observations on polyterritoriality and singing behaviour in the Wood warbler *Phylloscopus sibilatrix*. *Ornis Scand 15:* 67-72.

Tiainen, J. (1978): Nestling growth in three *Phylloscopus* warblers in Finland. *Ornis Fennica 55:* 1-15.

Tiainen, J (1983): Dynamics of a local population of the willow warbler *Phylloscopus trochilus* in Southern Finland. *Ornis Scand. 14:* 1-15.

Tiainen, J., Hanski, I.K. & Mehtala, J. (1983): Insulation of nests and the northern limits of three *Phylloscopus* species in Finland. *Ornis Scand. 14:* 149-153.

Williamson, K. (1974): Identification for ringers. 2. The genus *Phylloscopus*. British Trust for Ornithology, Tring, U.K.

HAEMOGLOBIN POLYMORPHISM IN ASIAN ELEPHANT *ELEPHAS MAXIMUS* WITH SPECIAL REFERENCE TO ELEPHANT POPULATION IN SOUTH INDIA[1]

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(*With a text-figure*)

Polyacryl Amide Gel Electrophoresis (PAGE) was used to study haemoglobin patterns in Indian elephants *Elephas maximus*. Blood samples were collected from 12 captive elephants at Mudumalai Sanctuary, Tamil Nadu. Out of 12 elephants, 10 (83.33%) showed two band Hb profile whereas 2 individuals (16.66%) showed a solitary haemoglobin (Hb) band, suggesting homozygosity of gene expression.

INTRODUCTION

Biochemical differentiation of species specific proteins can be established by using electrophoretic techniques (Selander *et al.* 1969, Yoshida *et al.* 1971 and De Smet and William 1978). Ferguson (1980) had recognized that although this technique was useful in establishing differences between forms, it was not successful in bringing out similarities between them. The limitations of the technique are overcome in the comparative blood sample study of various forms collected in an identical set of conditions with appropriate controls and the objective analysis of the data. Hb, being a stable molecule, is very useful in biochemical studies. There is no record of Hb patterns in elephants in available literature. P.E.P. Deraniyagala (1955) has proposed 7 living subspecies of the Asian elephant *Elephas maximus*, of which two are from India. This classification was based on morphological differences, amount of depigmentation and proportion of tuskers to tuskless males (*Maknas*) and tushed males (*Aliyas*).

Further, he has suggested that the Asian elephant is polymorphic and its wide range of individual variation has obscured the existence of a number of subspecies which have been revealed by studying the intensity with which certain variations are localized to different areas. In Sri Lanka and India, 10 main varieties and numerous sub-varieties have been recognized from the earliest times, subdivisions being based on shape, size, colour, voice, behaviour, strength, body odour, diet and susceptibility to certain diseases. In the light of this information it was felt that the use of PAGE may help in establishing biochemical polymorphic pattern, if any, in the Indian elephants. The frequency of occurrence of polymorphic locii and possible genetic inter-relations may also be ascertained by the analysis of the data on PAGE.

We are also working on 3 other proteins, viz. LDH, Esterase and SDH to assess polymorphism at specific gene locii. The results of these studies will be published in due course. We also plan to collect blood samples from the elephant populations of central and northern India to find out genetic affinities or differences, which will help in suggesting sub-specific status of the populations proposed earlier by different authors.

MATERIAL AND METHODS

Blood samples of 12 elephants were collected by Dr. V. Krishnamurthy, Project Officer, Indian Elephant Project, BNHS. Blood was withdrawn from the veins on the back of the ear using sterilized syringes and 16 gauge needles. Samples (5-10 ml each) were transferred to sterilized PVC bottles and allowed to thaw at room temperature for a few minutes to separate the serum. Then all the bottles were transferred to a liquid nitrogen cylinder(LN_2) to freeze them at $-192°C$. The samples were then transported with the cylinder to R.J. College, Bombay for laboratory analysis. Hb was solubilised from isolated RBC's after a treatment with hypotonic saline (0.02%).

Haemoglobins were separated by PAGE under precisely controlled factors like gel concentration (7.5%), buffer system (Tris-glycine, pH 8.4), voltage 250 mV, current 4 mA per tube, ambient temperature ($4°C \pm 1° C$), duration of run etc. Some of the samples were run successively to check the constancy of all factors which helped in the analysis

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TABLE 1
HAEMOGLOBIN VARIANTS IN TERMS OF RM VALUES, THEIR OCCURRENCE AND FREQUENCIES IN A SMALL DOMESTICATED ELEPHANT POPULATION IN SOUTH INDIA

Rm values with S.D.	No. of bands	% population (occurrence)	% frequency of bands
0.345 ± 0.015	1	8.33	4.54
0.355 ± 0.005	2	16.66	9.09
0.355 ± 0.015	1	8.33	4.54
0.37 ± 0.01	1	8.33	4.54
0.37 ± 0.02	1	8.33	4.54
0.375 ± 0.005	1	8.33	4.54
0.38 ± 0.02	1	8.33	4.54
0.385 ± 0.025	1	8.33	4.54
0.395 ± 0.005	1	8.33	4.54
0.56 ± 0.01	1	8.33	4.54
0.57 ± 0.02	1	8.33	4.54
0.575 ± 0.015	2	16.66	9.09
0.59 ± 0.02	1	8.33	4.54
0.595 ± 0.015	2	16.66	9.09
0.605 ± 0.015	3	25.00	13.63
0.61 ± 0.01	1	8.33	4.54
0.615 ± 0.015	1	8.33	4.54

Total no. of specimens – 12   Total no. of bands — 22

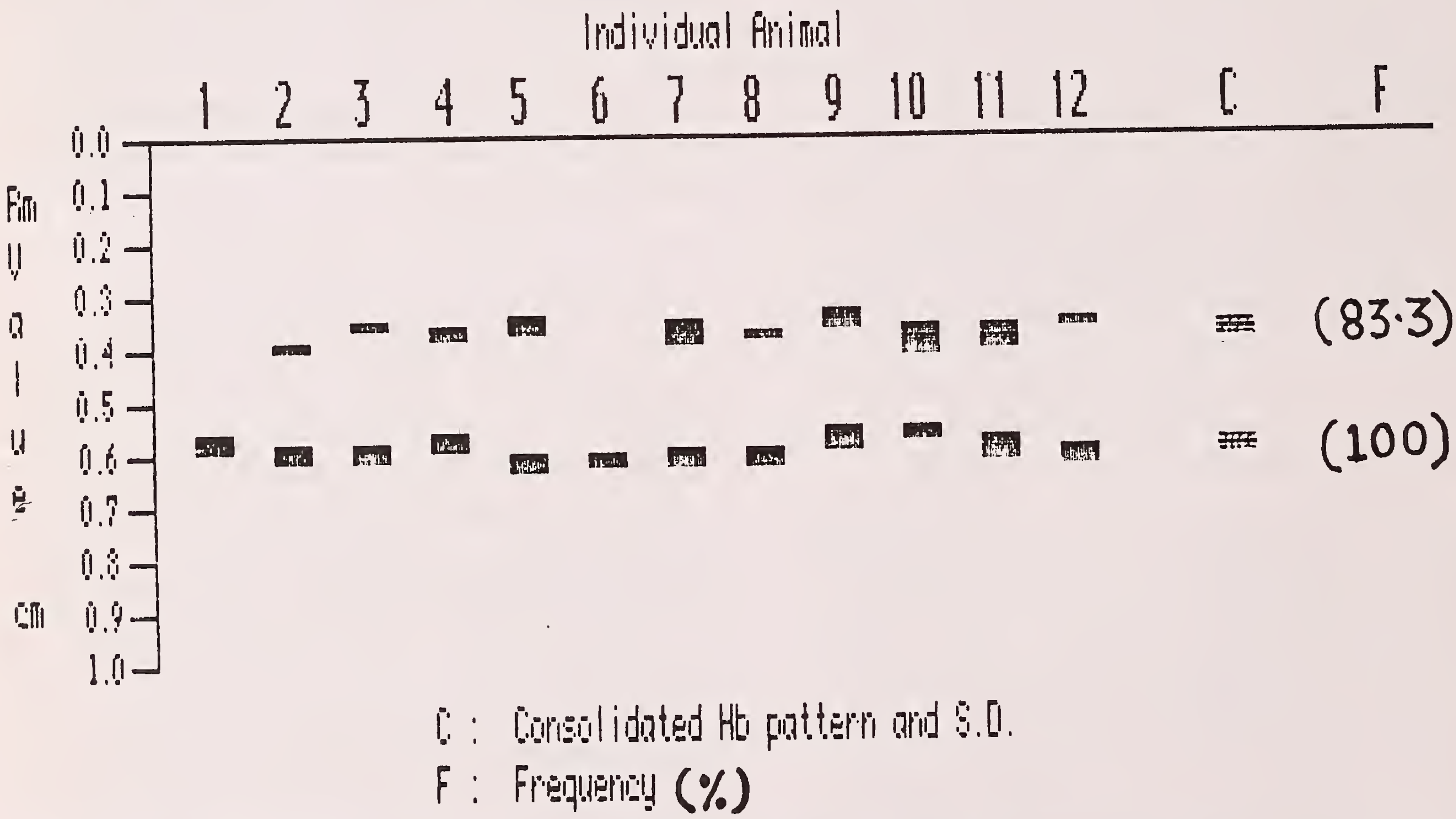

Fig. 1. Diagrammatic representation of haemoglobin profile of a small domesticated elephant population in south India

of the results. The dye Bromophenol Blue was loaded on the gel columns set in neutral glass tubes along with samples and served as a marker. For staining the gels after electrophoresis to identify Hb fractions, we followed the procedure of Ornstein (1967). Relative mobility (Rm) of Hb was calculated as a ratio of the distance travelled by Hb from the base to the distance travelled by the marker in the same run. The mean Rm with a standard deviation from the mean for each identified Hb band was recorded. Hb profiles for each individual were prepared by plotting Rm values and a consolidated

Hb profile for the population was constructed. Percentage occurrence of a fraction in the population and percentage frequency of each band was calculated. The band of the highest mobility was numbered Hb1 and band of lower mobility was numbered Hb2 as suggested by Ferguson (1980).

Results and Discussion

Table 1 shows records of the relative mobilities of haemoglobin fractions for 12 individual. The number of occurrences of a band in the population and its percentage frequency is given against each band. The same data are represented in Fig. 1 as a consolidated diagrammatic profile for the samples studied.

It is clear from Fig. 1 that out of 12 individual, 10 showed 2 pattern and 2 individual showed a solitary band suggesting homozygosity of gene expression for the Hb_1 locii. Thus it is evident that 16.66% of the population have homozygous expression, whereas 83.33% population show two banded expression. The Hb_1 pattern with the highest mobility is strongly expressed as compared to Hb_2 pattern. A single band profile for any protein is considered as an expression of homozygous gene locii specific for such protein (Ferguson 1980). However in the present study a homozygous pattern was found only for the locii of Hb_1 and not Hb_2. However, it is likely that the Hb_2 is also an expression of an independent gene locii with a slightly less frequency in the population.

Polymorphic expression of gene locii for Hb has been reported for rodents (Pradhan *et al.* 1984, Selander *et al.* 1969), birds (Sane *et al.* 1986). The Hb profile with an individual variation of single band to as many as a total of 15 bands on consolidation are reported for rodents, whereas for birds the number varies from one to six on consolidation. Thus in comparison, a two band pattern on consolidation in elephants appear to be more conservative.

Acknowledgements

We thank the Tamil Nadu forest department and Mr. Neelkantan, Wildlife Warden,Mudumalai Sanctuary for permitting us to collect blood samples from some of the captive elephants; Mr. Ajay Desai, Scientist, BNHS, who offered active participation and gave practical suggestions on collection of blood samples; the BNHS for providing the LN_2 cylinder for transportation of samples to Bombay; the Principal, R.J. College, Ghatkopar, Bombay, for providing the laboratory and other facilities and C. G. Rajendran and Ruben Solomon, R.J. College, for their great help in conducting the experiments.

References

Deraniyagala, P.E.P. (1955): Some extinct elephants, their relatives and the two living species. Govt. Press, Ceylon.

De Smet & William, H.C. (1978): A comparison of the electrophoretic haemoglobin pattern of the vertebrates. *Acta. Zool.Patholo. Antwerp.*, 70:119-131.

Ferguson, A. (1980): Biochemical systematics and Evolution. First Ed. Blackie, Glassgow, London.

Pradhan, M.S., Bhagwat, A.M. & Ingle, S.T. (1984): Haemoglobin polymorphism on PAGE in the five commensal rodent species (Subfam.: Murinae). Bulletin Z.S.I. Publ., Culcutta.

Pradhan, M.S., Bhagwat, A.M., Ingle, S.T. (1984): Haemoglobin polymorphism and genetic identities in five Indian commensal rodent species. 6th all India Congress of zoology. Gwalior.

Sane, S.R., Kannan, P., Rajendran, C.G., Ingle, S.T. & Bhagwat, A.M. (1986): On the Taxonomic status of *Psittacula intermedia* (Rothschild). *J. Bombay nat. Hist. Soc. 83:* 127-134.

Selander, R.K., Hunt, W.G. & Young, S.Y. (1969): Protein polymorphism and genetic heterozygosity in two European subspecies of the house mouse. *Evolution 23:* 379-390.

Yoshida, T.H., Kato, H., Tsuchiya, K. & Moriwaki, K. (1971): Karyotypes and serum transferrin patterns of hybrids between Asian and Oceanian black rats, *Rattus rattus. Chromosoma 34 (1):* 40-50.

BREEDING BEHAVIOUR AND MORPHOMETRIC RELATION OF *BUFO STOMATICUS* LUTKEN (ANURA : AMPHIBIA)[1]

B.K. Mahapatro and M.C. Dash[2]

(With a text-figure)

Breeding behaviour and morphometric measurements of *Bufo stomaticus* Lutken toads kept in a froggery were studied. Moderate temperature and high humidity during monsoon are favourable environmental conditions for egg laying. Male-male competition for mounting a female was common but in no case could the competing male separate the amplexed male. Amplex duration was 1-4 days. The clutch size varied from 9,000 to 11,000 eggs arranged in two parallel rows of jelly strings. The female toads were always larger than the males. Male and female toads found in amplexus were bigger than their non-amplexed population. Significant positive correlations between snout-vent length with body weight and with femur length were observed in the toads irrespective of sex and age. Such a correlation was also observed between body weight and gonad weight of immature and adult toads (toads more than five month old).

Introduction

The reproductive capacity of adults and the successful metamorphosis of the tadpoles lead to the abundance of adult anurans. Environmental factors such as rainfall, humidity, light and temperature have a profound effect on breeding activity (Savage 1961). Previous studies (Mohanty-Hejmadi 1974, Daniel 1975, Dutta and Mohanty-Hejmadi 1976, Mohanty-Hejmadi and Dutta 1979, Dash and Hota 1980, Mishra and Dash 1984) reported the breeding habits of some Indian amphibians. Mohanty and Das (1978) and Mohanty (1984) have reported on the induced breeding in Indian frogs. Khan (1965) prepared a life table for *Bufo stomaticus. B. stomaticus* is a common toad of this region and considering the scant literature on its breeding behaviour and morphometry, we studied these aspects.

Experimental Design

During the 1983 monsoon adult *Bufo stomaticus* toads were collected from beneath lamp posts in residential areas of Sambalpur University Campus, Sambalpur, Orissa and kept in the University's froggery. Some of them were selected sex-wise and morphometric measurements like total body length (snout to vent), femur length and body weight were recorded (N = 41 male and N = 45 female). These animals were killed and dissected to note the nature and weight of the gonads. The behaviour of mature toads during amplexus and egg laying were studied in the froggery. Morphometric measurements of amplexing pairs were also taken to determine the size at maturity.

Juvenile toads, metamorphosed in the laboratory, were maintained in the froggery only for five months as provisioning of food to the growing immatures was a big problem. The body length, femur length, body weight and gonad weight of these juveniles and immatures were measured sex-wise to determine growth rate (N = 20 male and N = 24 female). Climatological data for the area were collected from the Hirakud Research Station.

Results

Climate: The study area experiences mainly three seasons (i) summer from March to mid June, (ii) rains from mid June to mid October and (iii) autumn-winter from mid October to February. The maximum and minimum air temperatures recorded were 39.7°C in summer and 13.2°C in winter during 1983. RH was 91.6% at 08.30 hrs and 54.6% at 1730 hrs IST during the rainy season in 1983. The total rainfall in 1983 was 1497.1 mm with 112 rainy days. About 90% of total rain fell in the rainy season.

Habits and habitat: *Bufo stomaticus* Lutken, commonly known as the marbled toad, is found in India, Pakistan, Nepal and Sri Lanka. They are nocturnal and hide under stones and soil during the day. In summer they aestivate under earth even at a depth of over a metre (Rao 1923). The toads are equally at home under varying climatic conditions and during the breeding season, could be seen moving around

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TABLE 1

STATISTICAL RELATIONSHIP BETWEEN DIFFERENT MORPHOMETRIC PARAMETERS IN *Bufo stomaticus*

Morphometric parameters	Collected from	Sex	Regression equation	'r'	df	Significance
Body weight (Y) with S-V length (X)	Field	Male	Y = 0.952 x – 30.52	0.942	39	P <0.001
Femur length (Y) with S-V length (X)	-do-	-do-	Y = 0.388 x + 0.324	0.971	39	P <0.001
Testis weight (Y) with body weight (X)	-do-	-do-	Y = 2.111 x – 4.34	0.894	32	P <0.001
Body weight (Y) with S-V length (X)	-do-	Female	Y = 1.493 x– 63.718	0.896	43	P <0.001
Femur length (Y) with S-V length (X)	-do-	-do-	Y = 0.34 x + 2.077	0.917	43	P <0.001
Ovary weight (Y) with body weight (X)	-do-	-do-	Y = 0.221 x– 3.397	0.838	28	P <0.001
Body weight (Y) with S-V length (X)	Laboratory reared juveniles	Male	Y = 0.186 x– 2.694	0.956	18	P <0.001
Femur length (Y) with S-V length (X)	-do-	-do-	Y = 0.4164 x–1.104	0.985	18	P<0.001
Testis weight (Y) with body weight (X)	-do-	-do-	Y = 0.585 x + 2.039	0.518	11	ns at P0.05
Body weight (Y) with S-V length (X)	-do-	Female	Y = 0.253 x– 4.516	0.677	22	P <0.001
Femur length (Y) with S-V length (X)	-do-	-do-	Y = 0.4372 x–1.942	0.918	22	P<0.001
Ovary weight (Y) with body weight (X)	-do-	-do-	Y = 2.638 x + 17.887	0.34	18	ns at P<0.05

S-V = Snout-Vent   ns = not significant

TABLE 2

LENGTH AND WEIGHT OF MALE AND FEMALE *B. stomaticus* TAKEN FROM DIFFERENT CONDITIONS

Conditions	Morphometric parameter		Sex male	female	Value of 't'
Field collection	S-V length (mm)	N	41	45	t = 12.69
		X	58.83	67.42	df = 84
		SD	10.421	9.307	P <0.001
	Body weight (g)	N	41	45	t = 14.63
		X	25.49	36.94	df = 84
		SD	10.528	15.514	P <0.001
Laboratory reared	S-V length (mm)	N	20	24	t = 6.16
		X	25.25	29.42	df = 42
		SD	7.297	3.111	P <0.001
	Body weight (g)	N	20	24	t = 2.542
		X	2.003	2.927	df = 42
		SD	1.419	1.46	P <0.002
Amplexus	S-V length (mm)	N	10	10	t = 10.65
		X	64.1	73.8	df = 18
		SD	3.9	4.392	P <0.001
	Body weight (g)	N	10	10	t =18.37
		X	34.3	54.13	df = 18
		SD	3.959	7.69	P <0.001

SD = Standard deviation   S-V = Snout-Vent

during the day. They are solitary in nature but in captivity rested together in a jumbled heap. In captivity they fed on termites and earthworms. Adults are medium sized, measuring up to 81 mm, with heavily tuberculated skin.

Sexual dimorphism: Mature toads exhibit distinct sexual dimorphism. Males are smaller than females (average snout-vent length 64.1 mm and 73.8 mm, average body weight 34.3 g and 54.13 g in case of amplexing males and females respectively) and develop secondary sexual characters like a black vocal sac and black cornified patches on the inner sides of the first and second fingers. During the breeding season sexually mature males could be distinguished from others by the characteristic bright yellow body colour.

Amplexus: The pairing pattern was observed among the toads kept in the froggery. During the breeding season males produced a characteristic sound to attract female conspecifics. At first the male jumped onto the back of the female and clung to it by holding it below the arm pits with its forearms, and formed an amplexing pair which lasted for 1 to 4 days. During this period the female carried the male on its back while moving from place to place.

Neither male nor female toads exhibited any mate choice. Male-male pairing was avoided by producing a peculiar croaking if a male by chance climbed over another male. Male-male competition for a single female was prevalent.

In such cases a mature male first approached an amplexed pair, then rode over the pairing male and tried to separate the pair. During the course of the present investigation it was observed that in no case was the competing male successful in separating the amplexed male. It was also observed that considerable amount of force was required to separate the male from the amplex pairing so as to take morphometric measurements of the amplexed individuals.

Eggs and egg laying: Before egg laying the amplexed pairs moved towards a water source. Just before egg laying the female settled down near the water source. The male brought its hind limbs together to form a pouch into which the female released a number of eggs at a time. The male then ejaculated spermatic fluid over the eggs. After egg laying the female regained its normal position and the male withdrew its hind legs, allowing the egg strings to become loose. In this way eggs were laid in many instalments, hence the complete egg laying process lasted for 1 to 2 hours. Due to their sticky nature and the changing of position by the female after each instalment of egg laying, the egg strings were spread out.

The eggs were laid in two parallel rows of jelly strings entangled with the submerged substratum. Clutch size varied from 9,000 to 11,000 (by volume count). The average diameter of an egg was 1.3 mm. In laboratory condition eggs took 24 hours to hatch and the percentage of hatching depended on the spreading pattern of the egg strings. This toad generally breeds from mid June to September but the maximum number of breeding pairs was observed in July. In nature the toads even laid eggs in small garden pits having water level of 2 cm depth and drying of such pits might be one of the main causes for natural mortality of the larvae.

Morphometric relationship: Morphometric measurements such as snout-vent (S-V) length, femur length, body weight and gonad weight of the toads were taken sex-wise and the relationships between different parameters were analysed statistically. Results of the analysis (Table 1) indicated that there was significant positive correlation between body weight and S-V length, femur length and S-V length of male and female toads. The positive correlation between body weight and gonad weight was significant in the case of field population but statistically insignificant for juvenile toads reared in the froggery. Toads forming amplexus were larger and fatter than the non-amplexing toads (Table 3).

Discussion

Factors which affect oviposition have an important bearing on breeding biology. Packer (1960) found that breeding migration of *Terich rivularis* was provoked by rainfall. Alcala (1962) pointed out the necessity of rain for breeding to occur in *Rhacophorus leucomystax.* Dimmitt and Ruibal (1980) have listed sound/vibration as the primary and temperature, time of the day, amount of rainfall on preceding day, change in soil moisture etc. as secondary factors that may affect emergence of *Scophiopus couchi* from their winter burrows. During the present investigation oviposition was initiated by onset of monsoon rains and increased RH. Rain is necessary for breeding; this is supported by

the fact that more clutches were collected in July, the month of heavy rains. With the initiation of rains air temperature decreased from an average of 39.7° C in May to 33.2° C in July. During the monsoon moderate air temperature is coupled with high RH, particularly in the morning hours. We have observed that almost all the amplex pairs (N = 50) laid eggs during the morning hours (0700 to 1000 hrs) when low temperature and RH prevailed.

The mean size of the males in amplexus is greater than the mean size of the total male population (Gittins *et al.* 1980). Howard (1981) and Hemelaar (1983) concluded that at any stage adult female toads are bigger than adult male toads. Howard's (1981) view is that this difference in weight between female and male bull frogs is not the result of differential growth rate, but rather a sex-specific difference in the life history. This is also true in the case of *B. stomaticus*, where the females are larger than the males (Table 2) even from the very early juvenile stage (Fig. 1). We also observed that individuals found in amplexus are larger than the non-amplexing individuals (Table 3). These findings strengthen the view that female anurans are typically larger than their male counterparts (Crump 1974, Shine 1979).

Female reproductive success is determined more by the number of eggs laid than the number of

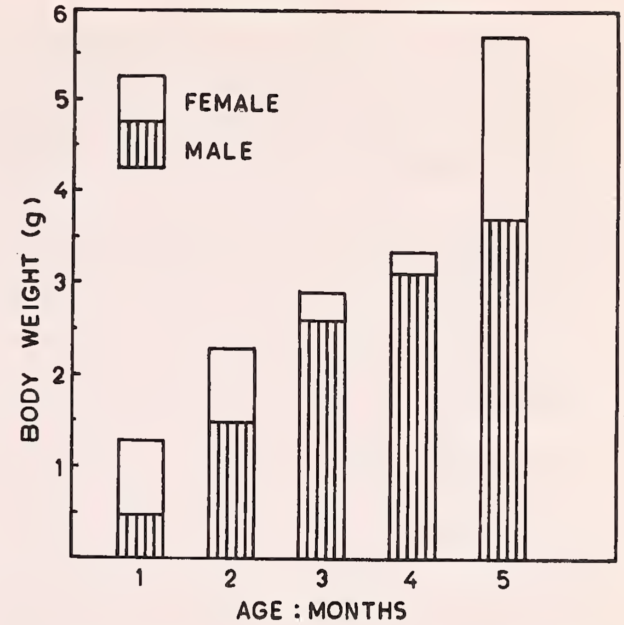

Fig. 1. Body mass histograms showing differential growth of male and female *B. stomaticus* with age.

young reared, and large female size permits a capacity for greater volume of eggs in each clutch (Howard 1981). In the present study the mean body mass of female *B. stomaticus* in amplexus was greater than that of the non-amplexing female population and the clutch size was found to be 9000 to 11000, a value much more than in other anurans like ranids, rhacophorids and hylids (Table 4). Such an observation extends support to the view that larger female body size may confer a reproductive

TABLE 3

A COMPARISON OF LENGTH AND WEIGHT OF MALE AND FEMALE *B. stomaticus* TOADS FOUND IN AMPLEXUS vs. FIELD POPULATION

Sex	Morphometric parameter		Condition of toads: Amplexing individuals	Field population	Value of 't'
Male	S-V length (mm)	N	10	41	t = 4.92
		$\bar{X}$	64.1	58.83	df = 49
		SD	3.9	10.421	P < 0.001
	Body weight (g)	N	10	41	t = 8.182
		$\bar{X}$	34.3	25.49	df = 49
		SD	3.959	10.528	P < 0.001
Female	S-V length (mm)	N	10	45	t = 6.27
		$\bar{X}$	73.8	67.42	df = 53
		SD	4.392	9.307	P < 0.001
	Body weight (g)	N	10	45	t = 13.2
		$\bar{X}$	54.13	36.94	df = 53
		SD	7.69	15.514	P < 0.001

SD = Standard Deviation S.V. = Snout-Vent

TABLE 4
A COMPARISON OF THE CLUTCH SIZE IN DIFFERENT ANURAN SPECIES

Species	Clutch size	References
Rana tigerina	1200–1800	Dash and Hota (1980), Pandian and Marian (1986)
Rana cyanophlyctis	980 –1538	Pandian and Marian (1986)
Polypedates maculatus	622	Mishra and Dash (1984)
Hyla sp.	221–482	Pandian and Marian (1986)
Bufo melanostictus	2000 –5000	Hota (1984), Pandian and Marian (1986)
Bufo stomaticus	9000–11000	Present study

advantage in many anurans due to a positive relationship between clutch size/volume and body size (Salthe and Duellman 1973, Crump 1974). Eggs were laid in two parallel strings, which confirms the description of Khan (1982) for identification of the eggs of *B. stomaticus*.

During hibernation the ovaries and oviducts practically do not change in weight (Zuszczyk and Zamachowski 1973). Young females below a particular size threshold do not mature sexually (Howard 1981). We have observed that gonad weight is significantly positively correlated with body weight in the case of bigger sized toads collected from the field, but insignificant in five month old juveniles reared in the froggery. The relationship is perhaps age specific.

REFERENCES

ALCALA, A.C. (1962): Breeding behaviour and early development of frogs of Negros, Philippine Island. *Copeia 1962*: 679-726.

CRUMP, M.L. (1974): Reproductive strategies in a tropical community. Miscellaneous Publications 61. University of Kansas Museum of Natural History, Lawrence, Kansas, U.S.A.

DANIEL, J.C. (1975): Field guide to the amphibians of Western India, part 3. *J. Bombay nat. Hist. Soc. 72(2)*: 506-522.

DASH, M.C. & HOTA, A.K. (1980): Density effects on the survival, growth rate and metamorphosis of *Rana tigrina*. tadpoles. *Ecology 61(5)*: 1025-1028.

DIMMITT, M.A. & RUIBAL, R. (1980): Exploitation of food resources by spadefoot toad (*Scophiopus*). *Copeia 1980(4)*: 854-862.

DUTTA, S.K. & MOHANTY-HEJMADI, P. (1976): Breeding and life history of the Indian bull frog, *Rana tigrina*. *Prakruti, Utkal Univ. J. Sci. 13 (1 & 2)*: 53-59.

GITTINS, S.P., PARKER, A.G. & SLATER, F.M. (1980): Mate assortment in the common toad (*Bufo bufo*). *J. Nat. Hist. 14*: 663-668.

HEMELAAR, A.S.M. (1983): Age of *Bufo bufo* in amplexus over the spawning period. *Oikos 40*: 1-5.

HOTA, A.K. (1984): Growth, production and energetics of tadpoles of *Rana tigrina* (Daud.) and *Bufo melanostictus* (Blouch and Schneider). Ph.D. Thesis. Sambalpur University, Orissa.

HOWARD, R.D. (1981): Sexual dimorphism in bull frogs. *Ecology 62 (2)*: 303-310.

KHAN, M.S. (1965): A normal table of *Bufo stomaticus* Lutken. *Biologia 11*: 1-39

KHAN, M.S. (1982): Collection, preservation and identification of amphibian eggs from the plains of Pakistan. *Pakistan J. Zool. 14(2)*: 241-243.

MISHRA, P.K. & DASH, M.C. (1984): Metamorphosis of *Polypedates maculatus* (Gray 1830): An analysis of crowding effect. *Alytes 3(4): 163-172*.

MOHANTY, S.N. (1984): Autecology of *Rana tigrina* (Daud.). Ph.D. Thesis. Sambalpur University, Orissa.

MOHANTY, S.N. & DAS, C.R. (1978): Effects of hypophysation on a partially ovulated Indian bull frog, *R. tigrina*. *In:* Symposium on Comparative Endocrinology held at Utkal University, Orissa.

MOHANTY-HEJMADI, P. (1974): Amphibian fauna of Orissa. *Prakruti, Utkal Univ. J. Sci. 11 (1 & 2)*: 89-97.

MOHANTY-HEJMADI, P. & DUTTA, S.K. (1979): Breeding and development of *Rana cyanophlyctis* Schneider. *J. Bombay nat. Hist. Soc. 76(2)*: 291-296.

PACKER, W.C. (1960): Bioclimatic influences on the breeding migration of *Taricha rivularis*. *Ecology 4*: 509-517.

PANDIAN, T.J. & MARIAN, M.P. (1986): Production and export of frogs: an ecological view. *In:* Proceedings of First World Conference on Trade in Frog legs vis-a-vis Environmental Considerations, Calcutta, India: 33-48.

RAO, C.R.N. (1923): Quoted from 'Field guide to the amphibians

of Western India' by J.C. Daniel. *J. Bombay nat. Hist. Soc. 60(2):* 415-438.

Salthe, S.N. & Duellman, W.E. (1973): Quantitative constraints associated with reproductive mode in anurans. *In:* J.L. Vial, ed. Evolutionary biology of the anurans. Univ. of Missouri Press, Columbia: 229-249:

Savage, R.M. (1961): The ecology and life history of the common frog (*Rana temporaria temporaria*). Sir Issac Pitman and Sons Ltd., London: 221.

Shine, R. (1979): Sexual selection and sexual dimorphisms in the amphibia. *Copeia 1979:* 297-306.

Zuszczyk, W. & Zamachowski, W. (1973): Morphological changes in the reproductive organs of the female edible frog, *Rana esculenta* (L.) in the annual cycle. *Acta Biol. Cracov. Ser. Zool. 16:* 167-178.

KEYS TO THE SUB-FAMILIES AND THEIR GENERA OF THE NON-TIBIAROLIATE GROUP OF ASSASSIN BUGS (HETEROPTERA: REDUVIIDAE)OF SOUTHERN INDIA[1]

DAVID LIVINGSTONE AND G. RAVICHANDRAN[2]

Keys for non-tibiaroliate group of Reduviidae, namely Harpactorinae Stenopodainae, Tribelocephalinae, Saicinae, Emesinae, Holoptilinae, and their 37 genera from Southern India have been given. Significant variations in their antennae, rostrum, head, pronotum, scutellum and appendicular chaetotaxy have been considered for the preparation of the keys.

INTRODUCTION

In his account on the reduviid fauna of the then British India, including Ceylon and Burma, Distant (1903, 1910) had relied upon collections deposited in various repositories abroad and very few species from southern India were represented. After Distant (1910), the first significant contribution on the taxonomy of Indian Reduviidae was made by Wygodzinsky (1966) by describing 5 genera and 8 species, in his monograph of Emesinae.

Apart from this, the taxonomic contributions of Indian Reduviidae are limited to the descriptions of a few species of Harpactorinae by Samuel and Joseph (1953). Subsequently, Muraleedharan (1976) described two new species of Henricohahnia. Years later, Wygodzinsky and Lent (1980), Ambrose and Livingstone (1986a), Livingstone and Murugan (1987) and Livingstone and Ravichandran (1988) added about half a dozen more species to the list of Reduviidae from southern India.

The first attempt in preparing a key for the genera of Reduviidae of the oriental region was made by Cook (1977) on Ectrichodiinae and since then it was desired to have akey for the genera of all the sub-families of the reduviid fauna of southern India.

At present, 168 species belonging to 65 genera and 11 sub-families of Reduviidae have been recorded from southern India and they are divisible into two major categories on the basis of the presence or absence of tibiarolium on the fore and mid tibiae or fore tibiae alone. The term 'tibiarolium' was coined by Mac-Gillivray (1923) to designate a pad like structure, similar to an 'arolium', at the distal end of tibiae, having been densely packed with fine hairs. Subsequently, the term 'Fossula spongiosa' (Miller 1938) and 'tibial pad' (Livingstone and Ambrose 1978) were coined to designate the same structure and Distant (1903) used the term 'spongy furrow'. The term tibiarolium is found to be more appropriate and in the present key, those sub-families without such a structure have been considered.

In his classification of Reduviidae, Distant (1903) enumerated 12 sub-families including Nabidinae. Later, China and Miller (1959) and subsequently Davis (1966), recognised 29 sub-families of Reduviidae from all over the world. Since, in the present collection of Reduviidae of southern India, only a few sub-families have been represented, it is preferred to adopt the classification of Distant. The non-tibiaroliate group of Reduviidae includes 6 sub-families, namely Harpactorinae, Stenopodainae, Tribelocephalinae, Emesinae, Holoptilinae and Saicinae.

There are 37 genera and 93 species recorded so far under this group in this region, of which 1 genus and 18 species are reported new to science and a number of species new records from southern India. The genus *Neohaematorrhophus* which was originally described under Ectrichodiinae by Ambrose and Livingstone (1986b) has characters suggestive of Harpactorine affinity and therefore it is also included under Harpactorinae. The keys for the genera have been prepared only for those sub-families that are represented by more than two genera.

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KEY TO THE SUB-FAMILIES OF THE NON-TIBIAROLIATE GROUP OF REDUVIIDAE OF SOUTHERN INDIA

1. Ocelli present 2
 Ocelli absent 3
2. Antennae and legs feathery ....Holoptilinae Stal
 Antennae either finely setaceous or longly pilose 5
3. First segment of the antennae incrassated, rostrum slender, elongate and elbowed at the junction of the first and second segments; clypeal process porrectly produced in front ....Tribelocephalinae Stal
 First segment of the antennae not incrassated; rostrum curved, second joint swollen or not swollen 4
4. First segment of the antennae elongate, and setaceous; second segment of the rostrum invariably swollen; pronotum longly spinous, fore coxae not elongate, fore tibia almost as long as the fore femora ....Saicinae Stal
 First segment of the antennae elongate, either setaceous or longly pilose; second segment of the rostrum either straight or swollen, fore coxae very elongate; fore femora incrassated and spinous; fore tibia invariably shorter than fore femora ....Emesinae Stal
5. Frontal forked tubercles porrectly produced; ocelli large, projecting outward; ante-ocular area invariably longer than post-ocular area; prosternal spine when present; porrectly produced; ante-ocular area parallel ......Stenopodainae Stal
 Frontal tubercles rarely present, ocelli moderately large, wide apart; ante-ocular area conical, tapering anteriorly... .... Harpactorinae Stal

KEY TO THE SOUTH INDIAN GENERA OF EMESINAE

1. Pronotal posterior lobe elongate, cylindrically produced, body elongate, setaceous ....*Stenolemus* Signoret
 Pronotum either almost uniformly elongate (or) subglobose; body invariably smooth 2
2. All the three segments of the thorax equally elongate, cylindrical; apterous .... *Ischnobaenella* Wygodzinsky
 Thoracic segments invariably globose, either alate or apterous 3
3. Fore trochanteral spine present; fore femora with biseriate spines ....*Ploiaria* Scopoli
 Fore trochanteral spine absent (or) setaceous; fore femora with single seriate long and short spines (or) with uniformly long spines 4
4. Fore trochanter setaceous; second rostral segment short, bulbous; body longly pilose, hemelytra embossed................ ....*Emesopsis* Uhler
 Second rostral segment not bulbous; foreleg tarsomeres either two segmented (or) three segmented 5
5. Foreleg tarsomeres two segmented and one fourth to one fifth as long as tibiae; appendages banded; wings highly spotted..*Empicoris* Wolff.
 Foreleg tarsomeres three segmented.................................6
6. First rostral segment as long as second; first tarsal segment more than twice as long as second and third combined ....*Bagauda* Bergroth
 First rostral segment as long as second; first tarsal segment longer than second (or) third ....*Gardena* Dohrn

KEY TO THE SOUTH INDIAN GENERA OF STENOPODAINAE STAL

1. Fore femora incrassated and ventrally armed.................... 2
 Fore femora either slender (or) slightly incrassated but unarmed 4
2. Ventrolateral margin of the ante-ocular area (loral lobes) expanded and armed with three to four strong robust spines ....*Staccia* Stal
 Ventrolateral margin of the ante-ocular area (loral lobes) not expanded and not spined 3
3. Posterolateral angles and anterolateral angles of the pronotum tuberculate; scutellum prominently tuberculate; propleural anterior spines obscure......*Oncocephalus* Klug
 Anterior lobe of the pronotum non-tuberculate, longer than posterior lobe; propleural spines elongate, porrectly produced; scutellar tubercules obscure ....*Sastrapada* Amyot & Serville
4. Fore and mid tibiae ventrally with elongate pad like structure; femora with mid ventral comb like setae; first segment of the rostrum almost half as long as the ante-ocular area; anterior lobe of the pronotum with sharply pointed spine, anterolateral and posterolateral angles and scutellum heavily spined .... *Canthesancus* Amyot &Serville
 Fore and mid tibiae slender; scutellum either tuberculate (or) non-tuberculate; first antennal segment short and incrassated or elongate and slender; anterior area of the pronotum tuberculous (or) non-tuberculous 5
5. Entire head, thorax, body, totally unarmed; propleural anterior spine absent .... *Hemisastrapada* gen. nov.
 Body invariably tuberculate or spined; propleural spine either tuberculate or spinous 6
6. First segment of the rostrum reaching almost the middle of the post-ocular area; propleural spines elongately porrectly produced; post genal row of tubercles, sometimes forked ....*Pygolampis* Germ.
 Propleural spine either tuberculate (or) obscurely spinous, antenniferous tubercles, frontal tubercles, porrectly produced; first rostral segment not reaching (or) almost reaching the eyes; first joint of antennae either short and incrassated or elongate and pilose; anterior lobe of pronotum either tuberculate (or) carinate 7
7. First antennal segment elongate and pilose; anterior lobe of the pronotum tuberculate; anterolateral and posterolateral angles spinously produced; scutellum elongately, porrectly spinous .... *Bardesanes* Distant
 Scutellum either elongately spinous or with nodule like tubercle; first antennal segment short and incrassated; anterior lobe sparingly tuberculate (or) carinate 8

8. Anterior lobe of the pronotum tuberculate; anterolateral and posterolateral angles moderately spinously produced; occiput with a pair of occipital, posteriorly developed warty tubercles; scutellum spinously produced ....*Caunus* Stal

Anterior lobe of pronotum non-tuberculate but faintly carinate; anterolateral and posterolateral angles non-spinous; scutellum with nodulose tubercles; post gena with a prominent ventrally directed tubercle ....*Diaditus* Stal

KEY TO THE SOUTH INDIAN GENERA OF HARPACTORINAE STAL

1. Ocelli present 2
Ocelli absent ....*Rhaphidosoma* Amyot & Serville

2 Pronotal spines present 3
Pronotal spines absent 11

3. Posterior lobe of the pronotum with discal spines............. 4
Posterior lobe of pronotum without discal spines 9

4. Scutellar spines present 5
Scutellar spines absent 6

5. Scutellum apically with a single spine; body absolutely bare; head bare but for a nodule like tubercle at the base of each antenna ....*Occamus* Distant

Scutellum with a median dorsal spine in addition to apical spine; pronotum, head and appendages highly spinous; spines at the base of antennae elongately produced ....*Polididus* Stal

6. Anterior lobe of the pronotum armed 7
Anterior lobe of the pronotum unarmed (or) obscurely tuberculate 8

7. Anterior lobe of pronotum with only the discal spines; head unarmed, but for short spine at the base of each antenna, legs unarmed ....*Brassivola* Distant

Anterior lobe of pronotum with a pair of long discal spines on each half, head highly spinous, with a very long spine at the base of each antenna; fore femora nodulose and highly spinous on each nodule ....*Irantha* Stal

8. Anterior lobe of pronotum with nodulose tubercles all around; spine at the base of each antenna very much elongate ....*Platerus* Distant

Anterior lobe of the pronotum without nodulose tubercles, but rugulose; spine at the base of antennae pointed, but short .... *Lanca* Distant

9. First rostral segment not passing the eyes; base of the antennae without spines; ante-and post-ocular areas almost sub-equal; spines of the lateral angles of the pronotum elongate and slender .... *Euagoras* Burmeister

First segment of the rostrum passing the eyes; spine at the base of each antenna moderately developed; ante-ocular area much shorter than post-ocular area 10

10. Discal area of posterior lobe of pronotum slightly angulate; spine at the base of antennae nodulose; first rostral segment as long as second and third combined... *Serendiba* Distant

Posterior lobe of pronotum not angulated; spine at the base of antennae short, but sharply pointed; first segment of the rostrumalmost as long as second and third combined ....*Endochus* Stal

11. Spine at the antennal base present; scutellum without spine 12
Head bare, scutellumwith or without spine 13

12. Femora nodulose; first segment of the rostrum much shorter than second; spine at the base of antennae very much elongated and curved outward .... *Macracanthopsis* Reuter

First segment of the rostrum longer than second segment; spine at the antennal base short and straight; femora not nodulose... *Cydnocoris* Stal

13. Scutellum with robust spine pointing vertically upward; collar cylindrical, much elongate; larger in size.................... ....*Sycanus* Amyot &Serville

Apex of the scutellum pointed but not spinous; collar very short; ante- and post -ocular areas either sub-equal (or) the former more elongate 14

14. Ante-ocular area almost twice as long as post-ocular area, first rostral segment obscure; second rostral segment elongate, straight................................ *Lophocephala* Laporte

First rostral segment a little shorter than the second segment; ante-and post-ocular areas sub-equal; anterior angles of the pronotum either tuberculate or smooth 15

15. Anterior lobe of the pronotum posteriorly truncated at the middle; antero-lateral angles obscurely tuberculous; scutellum posteriorly acutely pointed to tuberculate; lateral angles of the posterior lobe of pronotum expanded as paranotal lobe .... *Coranus* Curtis

Pronotal anterior lobe globose, either smooth or rugulose, antero-lateral angles of the pronotumwithmoderately developed tubercles; scutellum very minute bearing a median and lateral angulations 16

16. Fore and mid femora highly incrassated with fine tubercles on the ventral side; ante-ocular area slightly longer than post-ocular area .... *Neohaematorrhophus* Ambrose & Livingstone

Fore and mid femora not incrassated and tubercles absent on the ventral side; ante- and post-ocular areas sub-equal (or) the latter slightly more elongate 17

17. Anterior lobe of pronotum smooth, small and more globose; ante-and post-ocular areas sub-equal; scutellum non-tuberculate; posterior lobe of the pronotum almost smooth (or) finely granulate; small in size............ *Sphedanolestes* Stal

Ante-ocular area a little longer than post-ocular area; anterior lobe of pronotum with carinations and sulcations on either side; posterior lobe rugulose, scutellar tubercles slightly curved upward; large size ....,*Rhinocoris* Hahn

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REFERENCES

AMBROSE, D.P. (1985): Assassin bugs of Tamil Nadu and their Role in Biological Control (Insecta–Heteroptera-Reduviidae). *Proc. Natl. Sem. Entomoph. Ins.* pp. 16-28.

AMBROSE, D.P. & LIVINGSTONE, D. (1986a): A new species of *Rhinocoris* (Fabricius) from Southern India (Heteroptera : Reduviidae: Harpactorinae). *J. Bombay nat. Hist. Soc., 83 (1):* 173-177.

AMBROSE, D.P. & LIVINGSTONE, D. (1986b): A new genus of Ectrichodiinae from Southern India (Insecta: Heteroptera: Reduviidae). *J. Bombay nat. Hist. Soc. 83 (2):* 401-406.

CHINA, W.E. & MILLER, N.C.E. (1959): Checklist and keys to the families and sub-families of the Hemiptera: Heteroptera. *Bull. British Mus. (Nat. Hist.) Entomol. 8:* 1-45.

COOK, M.L. (1977): A key to the genera of Asian Ectrichodiinae (Hemiptera: Reduviidae) together with a Check List of genera and species. *Oriental Insects, 11 (1):* 63-68.

DAVIS, N.T. (1966): Contributions to the morphology and phylogeny of the Reduviidae (Hemiptera : Heteroptera) Part III. The male and female genitalia. *Ann. Entomol. Soc. Amer. 59(5):* 911-923.

DISTANT, W.L. (1903): The Fauna of British India including Ceylon and Burma, Rhynchota Vol. II. Heteroptera. Taylor and Francis, London, pp. 196-402.

DISTANT, W.L. (1910): The Fauna of British India including Ceylon and Burma, Rhynchota Vol. V, Heteroptera: Appendix. Taylor and Francis, London, pp. 169-220.

JOSEPH, M.T. (1959): Biology and Bionomics and Economic importance of some reduviids collected from Delhi. *Indian J. Ent. XXI(1):* 46-58.

LIVINGSTONE, D. & AMBROSE, D.P. (1978): Biology, Ecophysiology and Ethology of the reduviids of the scrub jungles of the Palghat-Gap, India. *J. Madras Univ. 4 (3):* 97-118.

LIVINGSTONE, D. & MURUGAN, C. (1987): A new genus of Ectrichodiinae from Point Calimere, Southern India (Heteroptera : Reduviidae) *Uttar Pradesh J. Zool. 7(1):* 92-95.

LIVINGSTONE, D. & RAVICHANDRAN, G. (1988): A new species of *Tribelocephala*, Stal (Heteroptera: Reduviidae: Tribelocephalinae), from Western Ghats. ibid *8 (1):* 100-102.

MACGILLIVRAY, A.D. (1923): External Insect Anatomy: A guide to the study of insect Anatomy and an Introduction to Systematic Entomology. Urbana III.

MILLER, N.C.E. (1938): Function of fossula spongiosa in Reduviidae. Nature, London. April, 749-750.

MURALEEDHARAN, N. (1976): Two new species of *Henricohahnia* from India (Heteroptera: Reduviidae: Harpactorinae). *Oriental Insects 10(1):* 51-54.

SAMUEL, C.K. & JOSEPH, M.T. (1953): On two new forms of Reduviids collected from Delhi (India). *Indian J. Ent. 15 (1):* 29-32.

WYGODZINSKY, P.W. (1966): A monograph of the Emesinae (Reduviidae: Hemiptera), *Bull. Amer. Mus. Nat. Hist. 133.* 1-614.

WYGODZINSKY, P.W. & LENT, H. (1980): Description of one new Monotypic Genus of Reduviidae from Panama and two from Southern India (Hemiptera: Reduviidae). *Rev. Brasil. Biol. 40(4):* 733-742.

NEW RECORD OF THE PIED HARRIER *CIRCUS MELANOLEUCOS* (PENNANT) BREEDING IN ASSAM DUARS, WITH A BRIEF REVIEW OF ITS DISTRIBUTION[1]

GOUTAM NARAYAN AND LIMA ROSALIND[2]

(*With two plates and two text-figures*)

The pied harrier *Circus melanoleucos* is described as a common winter visitor to the Indian subcontinent, particularly to its eastern part. Quite common in Manipur, Assam, Bangladesh, West Bengal, Bihar, Orissa and decreasingly so down the eastern side of the peninsula, it occurs in small numbers upto Sri Lanka (Ali and Ripley 1983).

It is seen very rarely in the Deccan peninsula and was not recorded north of Bombay in western India and west of Nepal terai and Gorakhpur district of Uttar Pradesh till recently. Rahmani (1988) had seen them in 1986 at Karera in Madhya Pradesh and now Prakash (1988) reports that two to three birds were seen in the winter months between 1985 and 1988 at Bharatpur in Rajasthan. It also winters in Burma and other countries of Indochina south to Borneo and Sule Islands (Brown and Amadon 1968). It is transient through eastern and central China, wintering in areas south of river Yangtze and in Hainan (de Schauensee1984) as well as the Philippines, where it is even suspected to breed (Dickinson 1986).

It is said to stay in India from October to April and is known to arrive at the breeding grounds (Transbaikal) in USSR about mid-April (Dementiev and Gladkov 1966).

Breeding range: Neufeldt (1967), quoting various sources, writes that the pied harrier breeds in the south-eastern USSR (western side of Sichote-Alin Range, Amur and Argun rivers, and probably upto Lake Baikal), north-eastern Mongolian Republic, northern part of Inner Mongolia and Manchuria in north-eastern China, probably penetrating into North Korea. There is no record of its breeding elsewhere in China.

From Burma there is only one nesting record by Stanford (1936), who found a nest in the grassy plains north of the confluence of Mogaung and Irrawaddy rivers in the Myitkyina district. Harrington (1903) had reported sighting these birds near Saga in southern Shan state in the month of July 1902 and thought they bred there.

Similarly, the only reliable nesting record of this bird from the Indian subcontinent is by J.R. Cripps, who found a couple of nests in Dibrugarh district of upper Assam in 1885. The eggs were collected from the 'churs' (alluvial grassy plains on islands and banks) of the river Brahmaputra and a place called Sepon south of the river (Hume 1888). These sites are approximately between the coordinates 27° 05' to 27°15' N and 94° 40' to 94° 50' E. Since the specimens were not collected by Cripps and the eggs eventually broke, there was some uncertainty regarding the species of harrier breeding in Assam. This is illustrated by Baker's (1935) comment that it is 'possible' that a few birds breed in the uplands of Assam while adding that "a reward offered to the local tribesmen of North Cachar, *Mikirs*, for the birds with eggs eventuated in a female harrier with four eggs in 1894. They had been kept for a long time and the bird was in remnant, but I then identified it as *C. aeruginosus*, though I now think it may have been *C. melanoleucos*."

There has never been any record of this bird staying in summer in the area north of river Brahmaputra in Assam. Moreover, in the present century there is no record of its breeding anywhere in the Indian subcontinent.

New breeding record: *C. melanoleucos* is one of the commonest harriers in the alluvial grasslands of the Manas Wildlife Sanctuary (26° 40' to 26° 50' E and 90° 45' to 91° 25' N) where we were engaged in the study of the Bengal florican *Houbaropsis bengalensis*. The Sanctuary is located along the foothills of Bhutan Himalayas in an area generally known as Assam duars and its elevation varies from 50 to 200 m. In 1987 we noticed that the *C. melanoleucos*, unlike the marsh (*C. aeruginosus*), hen (*C. cyaneus*) or the pale harrier (*C. macrourus*), did not disappear after winter and was seen regularly in summer months, although in smaller numbers. We suspected

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Above: Male pied harrier perched on a silk-cotton sapling close to the nest – its usual resting place between foraging and hunting rounds. It started providing food to the female even before laying of the eggs, and continued to feed the family single-handedly till nestlings were almost ready to fledge.

Below: Female pied harrier in breeding plumage perched on the camouflaged, remote-controlled camera near its nest.

Above: The nestlings perching on the grass around the nest when disturbed. The larger one is one month old, the other nine days younger.
Below: The female harrier with the younger nestling (18 days old) on the nest. It just appeared from shade of the mother's outstretched wings. The older nestling is resting in the shade behind the grass around the nest to avoid the heat.

their nesting in these vast grassy plains after we saw a male picking up dry grass or thin stalks and flying into tall grass area. We also heard them calling and saw a male displaying too, but could not locate any nest.

The nest: Following similar behaviour in 1988 another search was carried out and a nest under construction was located in open grasslands of Kasimdaha near Basbari on 23 March. The area was dominated by the grass *Saccharum narenga* growing densely up to 125 cm, dotted with a few isolated silk cotton *Bombax ceiba* saplings. The nest was loosely built on a clump of *c.* 100 cm tall grass growing on flat ground so densely that it supported the thin and haphazardly built nest well above the ground. It was difficult to define the bottom of nest as the nesting material kept slipping into the grass clump. However the thickness of the main part of the nest was hardly 10 cm in the beginning. Initially the external diameter was about 35 cm and the top of the nest was about 70 cm above the ground. The height decreased with time as the nest got bulkier and its occupants became heavier. After about two months, on 21 May, it had two growing nestlings and the height stood at 45 cm while the external and internal diameters were 55 cm and 25 cm respectively. At that time the grass in the immediate vicinity of the nest was 180 cm high while that in the surrounding area grew up to 220 cm. Shrubs like *Leea crispa* reached over 150 cm while the vegetation of the whole area became denser.

Chronology: The first egg was laid on 3 April and after the laying of an egg every alternate morning a clutch of 4 was completed on 9 April. Their sizes varied between 45 to 46 mm in length and 34 to 35.5 mm in breadth. The first egg began hatching after 31 days and the nestling was found on the morning of 5 May. The second nestling hatched the next day but the other two eggs remained unhatched till 14 May, when probably the last-laid egg hatched, 35 days after the last egg was laid. One of the eggs (probably the third) was later found to be addled. Meanwhile one of the older nestlings had died on 8 May, probably after falling from the nest. Thus there was a difference of 8 or 9 days between the two surviving nestlings which took to their wings in the latter half of June, about six weeks after hatching. By the beginning of July they were fully fledged and were seen infrequently.

At least three more pairs of *C. melanoleucos* were seen engaged in similar activity around the same period in different areas of the Sanctuary—Kuribeel, Palsiguri and Kapurpora—each more than a kilometre away from the others. A nest was found only at Kapurpora but the pair shifted their nest site after their first egg was probably preyed upon. When last seen on 6 May 1988 a new nest was being built. Soon afterwards the area became inaccessible and we could not continue close observations.

In 1989, a nest was again found at a place very close to the earlier site at Kasimdaha near Basbari. This time the clutch was of only three eggs and the nestlings hatched between 15 and 20 May. All three were growing satisfactorily when we left Manas on 30 May.

Discussion

The diameter, thickness and height of the *C. melanoleucos* nest in Manas differ considerably from those measured by Neufeldt (1967). In Amurland, U.S.S.R. the nests are much smaller, and are constructed on hummocks to escape flooding, while at Manas they are bulkier and are built on grass clumps or thickets in areas which are usually not flooded till the nesting is over. The habitat though similar in appearance, differs in constitution and is much flatter than the hummocky country described by Neufeldt. Another major difference is the season of breeding, which is from end May to August in U.S.S.R. compared to end March to June or beginning of July in Assam. In spite of the early season the weather in the breeding areas in Assam is probably warmer and wetter than that of central Asia (Table 1). Other features and activities of the nesting were quite similar to the description of their nesting in U.S.S.R. by Neufeldt.

The new breeding records from Manas Wildlife Sanctuary and sightings of adult and young *C. melanoleucos* in the breeding season, specially in May, at Orang Wildlife Sanctuary (26° 35' N, 92° 40' E) located on the northern bank of the river Brahmaputra proves that a few of these bird breed regularly in the alluvial grasslands south of Himalayas and north of Brahmaputra in lower Assam. Moreover, it is possible that they also breed in similar grasslands on the islands and southern bank of the river, as they were seen in Laokhowa Wildlife Sanctuary (26°30'N, 92°40'E),

TABLE
MEAN AIR TEMPERATURE IN SHADE AND RAINFALL AT BASBARI, MANAS WLS, IN THE BREEDING SEASON OF THE PIED HARRIER

	Mean Minimum Temp. in ° C			Mean Maximum Temp. in ° C			Temperature Range in °C	Rainfall in mm		
Month\Year	1987	1988	1989	1987	1988	1989	1987 to 1989	1987	1988	1989
March	17.4	17.5	17.3	27.0	28.3	28.8	13.5-32.5	115	65	25
April	20.4	20.8	20.2	28.4	30.2	29.7	16.5-34.5	210	190	260
May	22.4	22.9	22.9	30.9	29.5	30.9	19.0-35.0	310	530	275
June	24.9	24.9	–	31.2	32.4	–	23.0-35.0 *	1310	200	–

* No data for June 1989.

Burachapori and Kochmara Reserve Forests (26° 35' N, and 92° 30' to 92° 45' E), Kaziranga National Park (26° 30' to 26° 45' N and 93° 05' to 93° 40' E) and the Majuli islands (26° 50' to 27° N and 93° 50' to 94° 30' E) in the last week of April (Fig. 1).

The breeding areas in Assam and Burma are widely separated from their main breeding areas in the U.S.S.R., Mongolia and China (Fig. 2). The major factors responsible for this gap in the breeding areas appear to be the ecological barriers in the shape of the mountains of central China and the highly populated 'rice-belt' of eastern China. Neufeldt (1967) too feels that probably this disjunction arose in historical times as the vast plains of central and southern China have been cultivated for thousands of years, destroying the breeding habitats

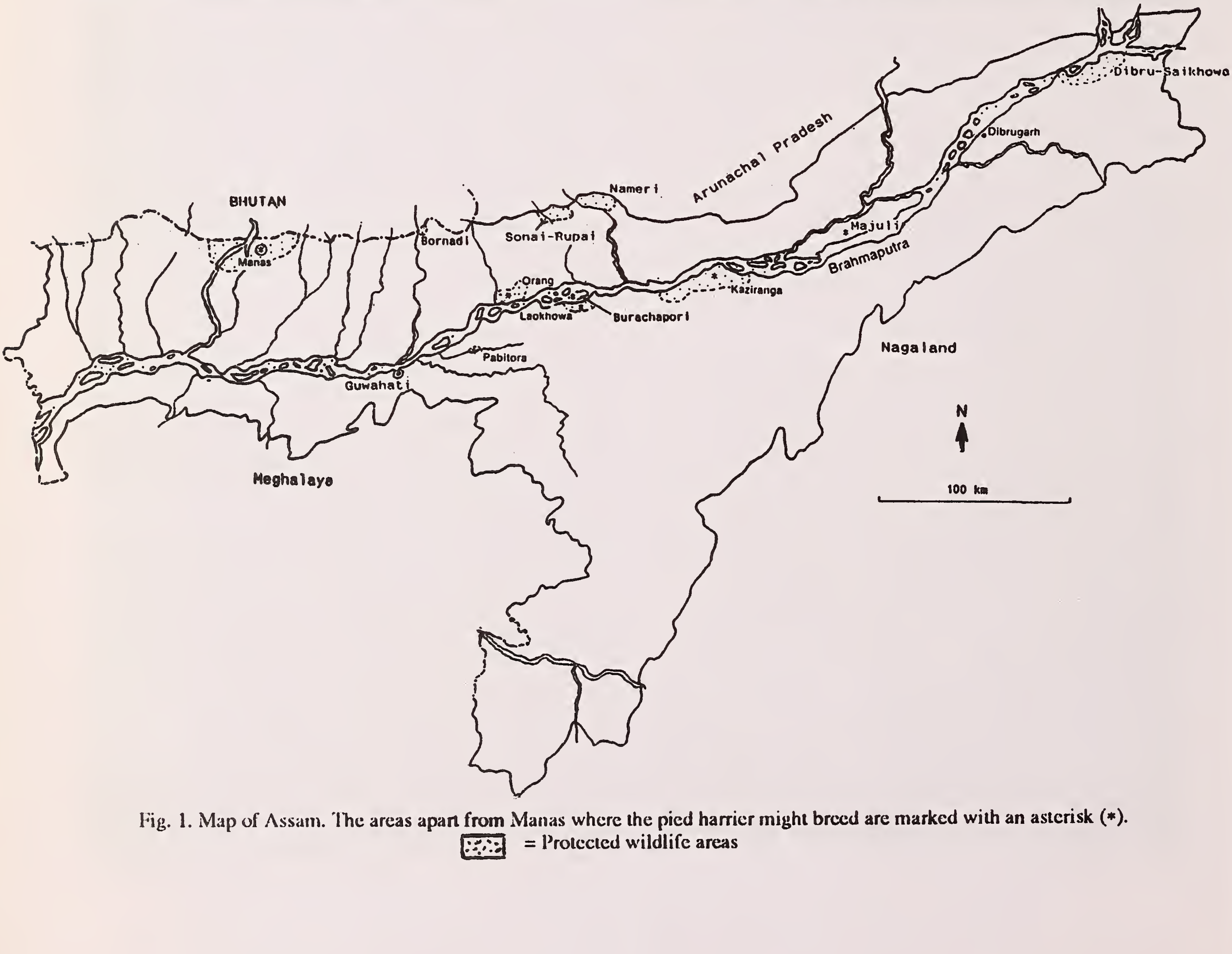

Fig. 1. Map of Assam. The areas apart from Manas where the pied harrier might breed are marked with an asterisk (*).
= Protected wildlife areas

Fig. 2. Breeding range of the pied harrier *Circus melanoleucos*.

of *C. melanoleucos* in the process.

As they need vast, flat, treeless and often swampy grasslands for breeding, it is possible that there is hardly any such habitat left in the region between the two breeding zones. However, these harriers winter in a large part of southern China and it is unlikely that all the suitable grasslands in such a vast area have been totally eliminated. It is possible that, like in Assam, there has been a lack of careful search in the plains of southern and central China. On the other hand, the bird perhaps does not breed in the area in spite of the presence of apparently suitable habitat. This phenomenon of patchy distribution, seen in many tropical birds, has also been explained as the result of local extinction (MacArthur 1972).

It is also possible that like scores of other migratory birds, *C. melanoleucos* has two seperate breeding populations, one of which is resident in a part of southern and south-eastern Asia while the other is a winter visitor from central Asia. Whatever the case may be, it is evident that a thorough search in north-eastern India, Burma and southern China in the breeding season as well as a detailed comparative morphological study of the individuals from both the areas is required.

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References

Ali, S. & Ripley, S.D. (1983): The Handbook of the Birds of India and Pakistan. Compact Edition. Oxford University Press, New Delhi.

Baker, S. (1935): The Nidification of the Birds of the Indian Empire, Vol. 4, pp. 96-97. Taylor and Francis, London.

Brown, L. & Amadon, D. (1968): Eagles, Hawks and Falcons of the World, vol. 1. Hamlyn, Feltham.

Dementiev, G.P. & Gladkov, N.A. (1966): Birds of the Soviet Union, vol. 1. Israel Program for Scientific Translations, Jerusalem.

De Schauensee, R.M. (1984): Birds of China.Oxford University Press, Oxford, England.

Dickinson, E.C. (1986): Does the Pied Harrier *Circus melanoleucos* breed in the Philippines? *Forktail 1:* 85-86.

Harrington, H.H. (1903): Birds Nesting in the Southern Shan States, of Burma. *J. Bombay Nat. Hist. Soc. 15:* 140-141.

Hume, A.O. (1888): Birds of Manipur, Assam, Sylhet and Cachar. *Stray Feathers 11(1):* 13-14.

Mac Arthur, R.H. (1972): Geographical Ecology– Patterns in the Distribution of Species. Harper & Row, New York.

Neufeldt, I.A. (1967): Notes on the Nidification of the Pied Harrier, *Circus melanoleucos* (Pennant), in Amurland, U.S.S.R. *J. Bombay nat. Hist. Soc. 64(2):* 284-306.

Prakash, V. (1988): The General Ecology of the Raptors in Keoladeo National Park, Bharatpur. Ph.D. thesis. Bombay University.

Rahmani, A.R. (1988): A Pied Harrier *Circus melanoleucos* in Northwest Madhya Pradesh. *J. Bombay nat. Hist. Soc. 85(2):* 419-420.

Stanford, J.K. (1936): On the Breeding of the Pied Harrier *Circus melanoleucos* (Pennant) in Northern Burma. *J. Bombay nat. Hist. Soc. 39 (1):* 179-181.

PRESENT DISTRIBUTION OF THE BLACKBUCK *ANTILOPE CERVICAPRA* LINN. IN INDIA, WITH SPECIAL EMPHASIS ON THE LESSER KNOWN POPULATIONS[1]

ASAD R. RAHMANI[2]

(*With a text-figure*)

INTRODUCTION

The blackbuck or Indian antelope *Antilope cervicapra* Linn. is endemic to the Indian subcontinent, being present in India, Pakistan and Nepal. During the last few years its ecology and behaviour has been studied by many workers (e.g. Mungall 1978a, b, 1979, Ranjitsinh 1982a, b, Prasad 1983, 1984, Prasad and Ramana Rao 1984, Bhattacharya and Chattopadhyay 1984). Censuses in Pt. Calimere (Daniel 1967, Johnson 1975, Nair 1976, Natarajan *et al.* 1978), Velavadar (Rashid 1977) and states like Gujarat (Sinha and Chhabra 1985) and Andhra Pradesh (Ramana Rao and Prasad 1982) have been done. Ranjitsinh's (1982a) assessment based on the official data supplied by the Forest Department gives a picture of the all-India distribution of the blackbuck, but in many instances exact locations have not been given and/or the population estimates have become outdated. For example, in the Karera Bustard Sanctuary in Madhya Pradesh, Ranjitsinh reported 8 blackbuck, but according to the 1988 census the population is now more than 500. Similarly, during the last seven or eight years I have noticed many scattered populations which have not been reported anywhere (except perhaps in official files).

The enactment of the Wildlife (Protection) Act 1972 has provided better protection to many wildlife species, resulting in a localised increase in the population of some animals like the blackbuck in newly established protected areas. Under these circumstances, it was felt necessary to re-assess the present distribution and status of the blackbuck in India. The main emphasis of this paper is on the description of the lesser known populations. Wherever available, census data are given and in some cases updated. Only a brief reference is made to well-known blackbuck areas like Velavadar, Pt. Calimere, Guindy and Rannibennur.

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STUDY PERIOD

This paper is a result of notes kept between 1981 and 1988 during our study on the Indian bustards. Blackbuck and the great Indian bustard *Ardeotis nigriceps* share common habitats, and as the bustard study involved much travel and surveys, I had the opportunity to visit a large number of blackbuck areas. All sightings of the blackbuck were noted. Additional information was gathered from the forest department, local people, naturalists and the existing literature. In many cases, census estimates are based on the information supplied by the Forest Department. As a proper census has not been done in all the areas, population counts are only approximate.

RESULTS

STATEWISE DISTRIBUTION OF BLACKBUCK

Uttar Pradesh: The blackbuck is very widely but thinly distributed in Uttar Pradesh, being present in at least 19 districts. Most of these populations are present in agricultural fields and grazing areas. It can also be seen in 6 out of 22 sanctuaries of the state (Table 1). According to R.P. Sharma, Chief Wildlife Warden of Uttar Pradesh, blackbuck are found in the following districts (population estimates in parentheses): Varanasi (90), Kanpur (35), Pilibhet (18), Lakhimpur Kheri and Shahjehanpur (40), Banda (21), Sitapur and Hardoi (51), Bijnor (75), Bahraich (82), Muzaffarnagar (50), Meerut (65), Aligarh (420), Bulandshahr (150) and Ghaziabad (10).

The total population comes to about 1100, which is slightly higher than Ranjitsinh's (1982) estimate of 941 to 1000 in 11 districts. However, Sharma has not included Etah and Mathura districts, where Ranjitsinh estimated 30 and 20 animals respectively. In both lists, Agra, Baduan and Etawah districts—where I know with certainty that blackbuck are still present—have been omitted. According to Prabhu Singh, Range Forest Officer, Mus-

TABLE 1
PROTECTED AREAS IN UTTAR PRADESH WITH BLACKBUCK HERDS

Name	District	Area (sq. km)	Blackbuck numbers	Reference
Katerniaghat	Bahraich	400	20-30	Pers. observ.
Kaimur	Mirzapur	501	250	Forest dept.
Ranipur	Banda	243	No data	-do-
Hastinapur	Meerut, Bijnor Ghaziabad & Moradabad	2070	No data	-do-
Kishanpur	Lakhimpur Kheri	227	15-20	Pers. observ.
Sikandra *	Agra	0.5	32 in 1978	Pers. observ.

* captive herd

tufabad, Pilibhet, who belongs to Baduan district, 1000-2000 blackbuck are present in Asafpur block of Bisoli tehsil in Baduan district. If this estimate is true, this must be the largest population of the blackbuck in the state, and efforts should be made to protect it. Baduan district adjoins Aligarh, where Sharma has reported the largest population (420) in his recent estimate. Another unknown population is present in the Jamuna *Khader* of Orai Range of Babain section in Etawah district. Among the captive herds outside zoos, a small population is present in Sikandra near Agra. Schaller (1967) counted 128 in 1965, but the following year (1966) only 104 were left (Spillett 1966). In 1978-79, I counted only 32, a clear drop of 72.65% in 12 years.

Comparing the blackbuck numbers in protected areas (sanctuaries and national parks) and unprotected areas (agricultural fields), we find that more than 80% of the blackbuck in Uttar Pradesh are found outside protected areas, where the Forest Department has little control. In these areas the blackbuck survives either due to sentimental protection by villagers or because the terrain makes motorized hunting difficult. Uttar Pradesh being one of the former strongholds of this species, a more systematic survey of the whole state is urgently required. A blackbuck sanctuary in Aligarh-Baduan region should be established.

Bihar: The blackbuck is making a slow comeback in some areas of Bihar. According to Shahi (1971), in the olden days "herds of thousands were found in the forests of Champaran and Shahabad but now a small population in some areas of Shahabad is fighting its last battle for survival". Fortunately, the picture is not so grim now: Ranjitsinh (1982a) estimated a population of 30 to 40 in the Shahabad area. However, according to the latest information given to me by Amar Prasad, Division Forest Officer, Purnea, blackbuck are present in large numbers in Buxar and Sasaram areas of south-east Bihar and due to crop damage, the Forest Department wants to translocate them to Khaimur plateau, where some animals are already present in open country between Jamgaon and Rajpur villages. The Bihar Government is also planning to develop a wildlife sanctuary in the Khaimur plateau like the one in the adjoining areas in Uttar Pradesh. Rodgers and Panwar (1988) have suggested creating a small 10 sq. km blackbuck refuge in a cropland/wasteland area near the Ganga river in Rohatas district.

Madhya Pradesh: The blackbuck is widely distributed in Madhya Pradesh and in many sanctuaries like Karera, numbers have increased during the last ten years. Ranjitsinh (1982a) found it to be present in eight sanctuaries and national parks and 12 districts. He estimated a population of 1300 in the whole state. Some of his data, based on the information supplied by the Forest Department, is not correct. For instance, he reported a population of 8 blackbuck in the Karera Bustard Sanctuary, but my estimate is that not less than 50 were present in 1982 and now the population is ten times as high.

Presently blackbuck are seen in 15 sanctuaries and national parks (Table 2) in Madhya Pradesh. They are seen in the following districts: Shivpuri, Gwalior, Morena, Ujjain, Dhar, Chhatterpur, Rajnandgaon, Raisen, Hoshangabad, Mandsaur, Vidisha, Guna, Damoh, Narsinghpur and Shahdol. Some of the sanctuaries mentioned in Table 2 are in these districts, but the blackbuck is also seen outside protected areas. Like in other states, no systematic survey has been done for the whole of Madhya Pradesh but population estimates for some sanctuaries like Kanha, Narodehi, Karera, Ghatiggaon and Kunu-Palpur are available (Table 2).

TABLE 2
BLACKBUCK POPULATION IN THE PROTECTED AREAS IN MADHYA PRADESH

Name	District	Area (sq. km)	Year of census	Blackbuck numbers	Reference
1. Karera	Shivpuri	202	1988	500-600	Pers. observ.
2. Kunu-Palpur	Shivpuri	345	1986	60-80	Pers. observ.
3. Ghatigaon	Gwalior	512	1988	100-150	Pers. observ.
4. Narodehi	Sagar	1186	–	466	Ranjitsinh (1982a)
5. Bagdara	Sidhi	478	–	313	Ranjitsinh (1982a)
6. Kanha	Mandla	940	1986	30	Pandey *et. al*. (1986)
7. Panna	Panna	543	1987	35-40	Forest Dept.
8. Chambal	Morena	3902	–	113	Ranjitsinh (1982a)
9. Sanjay	Sidhi-Sarguja	1938	–	No census data	Forest Dept.
10. Samarsoth	Sarguja	430	–	-do-	-do-
11. Son-Gharial	Sidhi-Shahdol	209	–	-do-	-do-
12. Tomar-Pingla	Sarguja	608	–	-do-	-do-
13. Ratapani	Raisen	689	–	-do-	-do-
14. Singhora	Raisen	288	–	-do-	-do-
15. Kheoni	Dewas-Sehore	123	–	-do-	

TABLE 3
SOME SCATTERED BLACKBUCK HERDS OUTSIDE THE PROTECTED AREAS IN MADHYA PRADESH

Name	District	Blackbuck numbers	Source	Remarks
Pipla- Agar taluka	Shahjapur	15-20	Forest Dept.	
Gautampura & Choddal villages in Badnagar taluka	Ujjain	100 (?)	Pers. observ.	Visited on 12 Sept. 1986 and saw many tracks
Kater Khera, close to Narbada river in Kuksi Range	Dhar	5	Range Forest Officer, Sailana	May 1986
Kotha plantation in Saleha Range	Panna	30-40	Forest Dept.	Visited on 5 Jan. 1988
Near Sumer between Bina and Bhopal	Vidisha	5	Q. Qureishi (1988 per. comm.)	Seen from the train on 23 July 1988.

TABLE 4
BLACKBUCK HERDS IN THE PROTECTED AREAS OF ORISSA

Name	District	Area (sq. km)	Blackbuck numbers	Reference
Balukhand-Konark	Puri	150	–	
Bhetonoi-Parushottampur	Ganjam	–	485	Patnaik & Acharjyo (1985)
Bhitarkanika	Cuttack	650	13 *	L.N. Acharjyo (1988,*in litt.*)

*Introduced

Orissa: Once found in all the suitable plains, the blackbuck in Orissa survives only in two districts: Balukhand and Chilka ranges of Puri district and Bhetonoi and Purushottampur areas of Ganjam district. According to a census conducted in 1980 in Bhetonoi and Purushottampur areas, 485 were counted (Patnaik and Acharjyo 1985). The Orissa government has declared a 150 sq. km coastal sanctuary called Balukhand-Konark Wildlife Sanctuary to protect the blackbuck and other wildlife. In the Bhitarkanika wildlife sanctuary, in order to build up a blackbuck stock, five (2 males and 3 females) were released in November 1985 from a captive herd of the Nandankanan Biological Park (L.N. Acharjyo, 1988 *in litt.*). In March 1987, another nine (7 males and 2 females) were released, out of which one died.

West Bengal: At present there is only one known area where blackbuck survive after being introduced more than 20 years ago. According to Bhat-

TABLE 5
BLACKBUCK NUMBERS IN PROTECTED AREAS OF ANDHRA PRADESH

Name	District	Area (sq. km)	Blackbuck numbers	Reference
Pranahita	Adilabad	136	No data	Forest Dept.
Eturnagaram	Warangal	803	-do-	-do-
Kinnerasani	Khammam	623	-do-	-do-
Nagarjunsagar -Srisailam	Guntur, Kurnool, Mehboobnagar, Nalgonda, Prakasan	3568	-do-	-do-
Rollapadu	Kurnool	6	40	Manakadan & Rahmani (1989)
Pakhal	Warangal	860	-do-	Forest Dept.
Mahavir Hiran Vanasthali *	Hyderabad	3.4	100	Forest Dept.

*Captive population

TABLE 6
BLACKBUCK HERDS OUTSIDE THE PROTECTED AREAS IN ANDHRA PRADESH

Name	District	Area (sq. km)	Blackbuck numbers	Reference
Mudmal	Mehboobnagar	80	95	Prasad & Ramana Rao (1990)
Mogullur	Prakasan	25	61	-do-
Seetarampuram	Prakasan	20	62	-do-
Guttumela	Khamman	10	8	-do-
Bayyaram	Khamman	20	25	-do-
Ravulapalam	West Godavari	25	56	-do-
Kedarlanke &Mudinanipalli	West Godavari	30	66	-do-
Kanigiri	Nellore	–	100	Forest Dept.
Kurichedu	Guntur	–	–	-do-
Grasslands of	Ranga Reddy	–	–	-do-
Punganoor Forest	Chittor	–	4 seen in one day	B.C. Chowdhury (pers. comm.)
Settur plantation near Kalyandurg	Anantapur	–	1 male and 1 female	K.P. Muniswamy (1988, *in litt.*)
Negalapuram	Anantapur	–	1	-do-
Maremmagude	Anantapur		4 (3 males, 1 female)	-do-
Mallegeli near Alur	Kurnool	–	1 male	R. Manakadan (1987 pers. comm.)
Kalichedu near Nelapattu	Nellore	–	3	Members of Madras Naturalist's Society (*Blackbuck* Vol. 4: 2, 1988)

tacharya and Chattopadhyay (1979), in 1955 an approximately 203 acre tract of eroded and barren laterite tract under the Ballavpur Forest Range, close to Shantiniketan, was afforested. About 100 acres were fenced to establish a "Deer Conservation Unit". In 1967, four male and seven female blackbuck were introduced, which increased to 54 by 1975. At present the population is estimated to be 140.

Andhra Pradesh: Ramana Rao and Prasad (1982) and Prasad and Ramana Rao (1990) have listed areas where blackbuck are distributed in Andhra Pradesh. However, a few lesser-known areas like Rollapadu in Kurnool district and Punganoor Forest Range in Chittor district have not been included by them. There are still more areas (see Table 6) in Guntur, Mehboobnagar, Khammam, Anantapur, Prakasan and Ranga Reddy districts where scattered herds of blackbuck are seen, Among the 16 wildlife sanctuaries in Andhra Pradesh, blackbuck are found in six (Table 5), excluding the captive animals in Mahavir Hiran Vanasthali near Hyderabad.

TABLE 7
PROTECTED AREAS IN KARNATAKA HAVING BLACKBUCK HERDS

Name	District	Area (sq. km)	Blackbuck number	Reference
Rannibennur	Dharwad	119	> 2000	Neginhal 1980; and pers. obs.
Melkote	Mandhya	50	No data	Forest Department
Adi Chunchanagiri	Mandhya	0.8	-do-	-do-
Chincholi	Gulbarga	80	-do-	-do-

Karnataka: Blackbuck in Karnataka have suffered a massive decline and disappeared from most areas. The largest extant population is present in the Rannibennur Blackbuck Sanctuary (Neginhal 1980, and pers. obs.) where nearly 2000 can be seen. In addition to Rannibennur, there are three more sanctuaries in Karnataka where blackbuck are present (Table 7).

According to the information collected by Ranjitsinh (1982a) isolated herds are seen in Mandhya, Tumkur and Bidar districts, but M.K Appayya (1988, *in litt.*) mentions only Mandhya, Dharwar, Gulbarga, Raichur, Bellary and Bijapur districts and not Tumkur and Bidar. It could not be confirmed whether the isolated herds in Tumkur and Bidar mentioned by Ranjitsinh (1982a) have disappeared or were overlooked by Appayya.

In Raichur district, on Raichur-Hyderabad road on the banks of the Krishna river, some blackbuck are present. Here the Krishna forms the boundary between Karnataka and Andhra Pradesh, and blackbuck can be seen on both sides. Ramana Rao and Prasad (1982) have mentioned this area in their report, and S. Sreevatsa (1987, pers. comm.) has seen 44 blackbuck in one day. The second area which appears to be unknown is Makri in Shimoga district, where P. Shroff (1988, pers. comm.) has seen 50 to 60 bucks in April 1987. The area is flat and under agriculture fields.

Tamil Nadu: In Tamil Nadu, Pt. Calimere Wildlife Sanctuary and Guindy National Park are two well-known blackbuck areas. It is not so well-known that there are more areas in this state which may have a population of more than 500 blackbuck.

1. Sujjalkatte Sanctuary (Proposed): Sujjalkatte is on the eastern side of the Nilgiris, and the blackbuck is found in a 10 sq.km flat and degraded area between Mangalapathi and Bhavani Sagar in the Sathymangalam range (N. Sivaganesan 1988, pers. comm.). According to the Forest Department estimate there are now 400 antelopes in that area. Earlier, Ranjitsinh (1982a) had reported 150 to 200 blackbuck. According to Sivaganesan's estimate there are nearly 300 animals. In a day's trip he saw 57.

2. North Arcot district: Rajasingh (1984) has described a dramatic increase of blackbuck population from five individuals in 1968 to 92 in Alliyalamangalam Reserve Forest, about 145 km south-west of Madras city.

3. Tirunelveli district: Ranjitsinh (1982a) reported a population of 30 animals in Vallanadu Reserve Forest in Tirunelveli district, but according to the District Forest Officer (1988 *in litt.*) the population has gone up to 100 in the reserve area of 2054 ha. There is a proposal to set up a blackbuck sanctuary in Vallanadu.

Maharashtra: There are at least a dozen lesser known areas in Maharashtra where blackbuck are present. In some places like Nanaj, Karmala and Kasegaon in Solapur (Rahmani and Manakadan 1989) and Rekhuri in Ahmednagar (E. Bharucha 1988, pers. comm.) the blackbuck population has gone up considerably and is causing crop damage. Ranjitsinh (1982a) reported its occurrence in Osmanabad, Bhir, Parbhani, Nanded, Solapur, Ahmednagar and Wardha districts and estimated a total of 1000 blackbuck in the whole state. Ramana Rao and Prasad (1982) found it occurring in Yeotmal, Bhir, Parbhani, Nagpur, Ahmednagar, Amravati and Wardha. Strangely, Solapur district, where the largest number of blackbuck in the whole state are seen, was omitted by them.

Owing to habitat restoration and effective protection under the Drought Prone Areas Programme (DPAP) and various afforestation schemes, the blackbuck is repopulating many areas and can sometimes be seen from the national high-

TABLE 8
BLACKBUCK POPULATIONS IN VARIOUS DISTRICTS OF MAHARASHTRA

District	Important areas/taluk	Total Population	Remarks	Reference
Solapur	whole district	3300	–	Pers. observ. & Forest Dept. records
Ahmednagar	Karjat, Shrigondha, Parner and Jhamkhed talukas	500-600	250-300 in Rehkuri	Pers. observ. & Forest Dept. records
Aurangabad	Near Kasota village in Kannad taluka	10-15	Seen in silviculture plot of 25 ha	Forest Dept.t
Osmanabad	Umarga, Bhoom, Paranda and Tuljapur talukas	No data	180 seen in Gangaivadi plot on 11 July 1988	Pers. observ.
Beed (= Bhir)	Near Naigaon in Goirai taluka	'few'	–	Forest Dept.
Sangli	Jath, Kawthimankal, Islampur and Khanapur talukas	No data	'scattered herds'	-do-
Pune	Dhaund, Indapur, Baramati, Shirur and Purandhar	No data	'scattered herds'	-do-
Nanded	Hingola and Kinwat talukas	No data	-do-	-do-
Buldana	Malkapur taluka	No data	Proposal to develop a sanctuary of dry grassland ecosystem	Rodgers & Panwar (1988) and Forest Dept.
Akola	Karanja, Murtijapur and Chickalchalwal talukas	100-150	Potential to develop a blackbuck sanctuary in Karanja taluka	-do-
Amravati	17 km from Amravati on Yeotmal road	18-20	Seen in winter of 1986	Karkare (1988 pers. comm.)
	Near Borgaon on Akola road	4	Seen in winter of 1986	-do-
Bhandara	Margi area	50		P. Job (1988 pers. comm.)
Yeotmal	Wani forest in Tipeshwar	No data	Proposal to develop a blackbuck sanctuary in 225 sq .km	

ways. For example, on 24 October 1984, seven animals were seen by me on Pune-Solapur highway, about 17 km before Solapur. Similarly, P. Gole (1988, pers. comm.) in January 1988 saw three blackbuck from a bus between Jhamkhed (in Ahmednagar district) and Beed (=Bhir). The total blackbuck population in Maharashtra may be between 4500 and 5000, with Solapur district having more than half the total (Table 8).

Punjab: The plains of Punjab (and Haryana) were some of the chief strongholds of the blackbuck in north India. Even 30 years ago, it was found in Ferozpur, Faridkot, Ludhiana, Ropar, Bhatinda and Sangrur districts, but now the blackbuck survives only in Abohar area in Faridkot, where up to 3500 can be seen (Parshad 1984). The blackbuck around 13 Vishnoi villages covering an area of 182 sq. km were given full protection in 1982 in deference to the demands by the Vishnois that their antelopes be saved (Singh 1984). In all other places in Punjab the blackbuck is extinct, except for some semi-captive herds in Chhat Bir near Chandigarh, Bir Motibagh Patiala and Bir Gurdial Pura.

Haryana: The largest recorded herd of 10,000 blackbuck was seen in a grassland in Hissar district in Haryana (Jerdon 1874). In 1955 and 1956, Ranjitsinh (1982a) saw "sizeable herds in the same tract, including one of over a hundred in sight of Hissar town. By 1961, there were no signs of blackbuck on the same ground". However, H. Dang (1964) reported seeing over a hundred blackbuck in the Hissar area, and added "reports would put the figure at thrice that number". He also estimated about 300 in *Khader* area of Ferozpur, 100 in Rewari, and 300 in Kapurthala. According to R. Dang (1988, pers. comm.) there are three blackbuck refuges, and a population of about 400 animals is present at some distance from Sultanpur Bird Sanctuary in Gurgaon

TABLE 9
BLACKBUCK HERDS OUTSIDE PROTECTED AREAS IN GUJARAT

Name	District	Blackbuck numbers	References
Kadi	Mehsana	> 300	A. Daga (1988 pers. comm.)
Latuda-Katuda	Surendranagar	> 200	Y. Jhala (1988 pers. comm.)
Karara (Wandhwan to Limdi)	Surendranagar	> 10	-do-
Wandhwan	Surendranagar	15	-do-
Little Rann	Surendranagar and Kutch	300	Sinha & Chhabra (1985)
Dhankaniya veedi Botad taluka	Bhavnagar	350	Sinha & Chhbra (1985) and Pers. observ.
Near Port Victor	Bhavnagar	40	Sinha & Chhabra (1985)
Umavadi veedi in Gondal	Rajkot	10-15	Upadhyay (1988 pers. comm.)
Near Rajula	Amreli	40	Sinha & Chhabra (1985)
Near Damnagar	Amreli	20	-do-
Near Lathi	Amreli	15	-do-
Near Jhajmar	Junagadh	25	-do-
Near Kotda	Junagadh	50	-do-
Sunderpura	Vadodra	350	Oza (1978) and Rahmani & D'Silva (1984)
Kandorna Rana	Porbander	40 seen in one day	Mohile (1981)

TABLE 10
PROTECTED AREAS IN RAJASTHAN WITH BLACKBUCK POPULATIONS

Name	District	Area (sq. km)	Year of census	Blackbuck numbers	Reference
Keoladeo	Bharatpur	29	1987	18	Haque (1988)
Talchapper	Churu	7	1986	1400	Pers. observ.
Gajner	Bikaner	25	1981	575	Forest Dept.
Sorson	Kota	40	1988	80-100	Pers. observ.
Guru-Bishnonian	Jodhpur	425	1987	6163 3-4000	S. Sharma (pers. comm.) Prakash (1988)
Dhawa-Doli	Jodhpur	470	1987	3000	-do-
Sathri	Jodhpur	245	1987	'few'	Forest Dept.

district. There is a proposal to establish a blackbuck sanctuary near Sirsa among 12 to 13 villages dominated by the Vishnoi community, who do not kill these antelopes (G. Singh, 1989 pers. comm.).

Gujarat: The Velavadar National Park in Bhavnagar district is one of the most famous protected areas for blackbuck in India. It was specially created in 1969 for the protection of this antelope. Not many people know that there are more than a dozen other places in Gujarat where blackbuck can be seen. In four such areas, the population of blackbuck is more than a hundred each. Ranjitsinh (1982a) estimated that the total blackbuck population in Gujarat may be 3300 to 3500, while Sinha and Chhabra (1985) estimated 3295 blackbuck in the whole state. In some areas like Kadi in Mehsana the population has gone up. For example, Sinha and Chhabra (1985) reported only 75 blackbuck but in October 1987, A. Daga (1987, pers. comm.) saw nearly 300. Similarly, a few places like Latuda-Katuda and Umvadi veedi in Gondal where blackbuck are seen were not mentioned by Ranjitsinh (1982a) or by Sinha and Chhabra (1985). Therefore a fresh assessment of the blackbuck population in Gujarat should be done.

Rajasthan: Among the Indian states the highest number of blackbuck are present in Rajasthan. Ranjitsinh (1982a) estimated between 7600 and 8000 blackbuck in the whole of Rajasthan, but according to the recent census done by the Forest Department, in Jodhpur district alone, nearly 10,000 are found in Guru-Bishnonian and Dhawa-Doli areas (S. Sharma 1987, pers. comm.) However, S.P. Goyal (1988,

TABLE 11
BLACKBUCK HERDS OUTSIDE THE PROTECTED AREAS IN RAJASTHAN

Name	District	Date of sighting	Estimated No.	Reference/Source
Raja-Kheri ravine	Dholpur	–	10-15	Forest Dept.
Khamer to Sareri	Bhilwara	–	> 150	Forest Dept.
50 Km from Jodhpur on Pali road	Pali	26 July 1987	> 100	Pers. obs.
Dudli in Rohat	Pali	26 July 1987	150-300	Pers. obs.
Near Omkali	Pali	26 July 1987	10-12	Pers. obs.
Raniwara	Jalore	–	'few'	S.P. Goyal (1988 *in litt.*)
Near Johdi	Alwar	–	400	Rodgers & Panwar (1988)
Lamba	Jodhpur	22 Jan. 1987	150-200	Pers. obs.
Near Banai	Jodhpur	22 Jan. 1987	10-15	Pers. obs.
Near Diyatra	Bikaner	22 Jan. 1986	11	Pers. obs.
Raisinghnagar	Bikaner	–	2000(?)	Forest Dept.
Ranipur	Tonk	–	100	Forest Dept.

TABLE 12
NEW PROTECTED AREAS WHERE BLACKBUCK POPULATION HAS INCREASED

Name	Earlier population estimates	Recent population estimates	Reference
Karera Bustard Sanctuary	50-60 in 1982	500-600 in 1988	Pers. obs.
Ghatigaon Bustard Sanctuary	20-25 in 1982	100-150 in 1988	Pers. obs.
Sorson Closed Area	15-20 in 1983-84	80-100 in 1988	Pers. obs.
Nanaj	150-200 in 1981	600-800 in 1988	Pers. obs.
Kasegaon (Gangiawadi)	25-35 in 1983	180-210 in 1988	Pers. obs.
Rehkuri Blackbuck Sanctuary	70-80 in 1982	250-300 in 1987	Pers. obs.
Rollapadu Bustard Sanctuary	10-12 in 1984	38-40 in 1988	Pers. obs.
Ballavpur Forest	11 in 1967	140 in 1988	Bhattacharya &Chattopadhyay (1979) and Forest Dept.
Alliyalamangalam	5 in 1968	92 in 1982	Rajasingh (1984)
Vellanadu	30 in 1981	100 in 1988	Ranjitsinh (1982a) and Forest Dept..

pers. comm.) feels that the population is not so high. Apart from Jodhpur, the blackbuck is seen in Kota, Ajmer, Pali, Bikaner, Churu, Ganganagar, Bharatpur, Dholpur and Bhilwara districts (Tables 10, 11).

DISCUSSION

Ranjitsinh (1982a) estimated the total blackbuck population in India to be between 22,000 and 24,000. Since then the population has increased, especially in newly created protected areas like Karera, Ghatigaon, Nanaj and Rehkuri (Table 12). According to my rough estimate, the blackbuck population may now be between 29,000 and 38,000. This large gap between the maximum and minimum population estimates is mainly due to the rather questionable official and non-official figures.

It is clear from Table 13 that the population increase during the last decade is seen not in the important sanctuaries like Pt. Calimere, Velavadar and Rannibennur (which were specially created for the protection of this species), but in newly created sanctuaries like Karera, Rollapadu, Rehkuri and Nanaj. In some of the important blackbuck sanctuaries the population has actually gone down (e.g. Pt. Calimere).

In protected areas such as Karera and Nanaj, and Vishnoi areas of Rajasthan, the blackbuck is seen in private fields where the Forest Department has not much control on the land use. As emphasized by Rodgers and Panwar (1988) such areas have a dubious long-term wildlife value and should not be taken as a guarantee for the safety of a species. Occurrence of blackbuck in cultivated areas and the resultant crop damage may even result in development of a negative attitude towards conservation, thus jeopardizing the future of such populations.

Fig. 1. Present sight records of blackbuck in India

Similarly, survival of blackbuck in isolated pockets in the highly populated districts of Uttar Pradesh or Bihar may not be guaranteed forever, especially when the human population is still increasing and habitat alteration is accelerating everywhere.

Though there may be more than a thousand blackbuck in Uttar Pradesh, more than 80% of the population survives in areas which may in future not remain suitable for the species. Therefore the opinion that populations have increased so much that the blackbuck should be removed from Schedule I of the Wildlife (Protection) Act is not tenable: it is not that the species is threatened, but that the habitat which it occupies is in danger of further alteration. Unless the habitat is protected, there is no long-term guarantee of the species' survival. Therefore, in my opinion, the blackbuck should remain in Schedule I and some more areas should be identified to be developed as blackbuck sanctuaries.

Rodgers and Panwar (1988) have shown that

TABLE 13
POPULATION ESTIMATES OF BLACKBUCK IN WELL-KNOWN SANCTUARIES

Name	Year of census	No. of blackbuck	Reference
Pt. Calimere	1967	750-800	Daniel (1967)
	1971	970	Johnson (1975)
	1974	340	Nair (1976) (see Johnson (1982) for contradiction of census figures)
	1977	506 (actual count)	Natarajan *et al.*. (1978).
	1980	1100	Forest Dept. (in Ramana Rao & Prasad 1982)
	1988	550	Alagar Rajan *et. al.* (in prep.)
Kanha	1965	21	Schaller (1967)
	1972	90	Martin (1977)
	1986	30	Pandey *et al.* (1986)
Keoladeo	1965	70	Spillett (1968)
	1980	24-26	Pers. observ.
	1987	18	Haque (1988)
Velavadar	1969	*c.* 400	Rashid (1977)
	1977	1678	Rashid (1977) & Dharmakumarsinhji (1978)
	1985	2000	Sinha & Chhabra (1985)
	1989	900	A. Jhalla (Pers. comm.)
Rannibennur	1958	'very few'	Neginhal (1980)
	1970	*c.* 600	-do-
	1974	1000	-do-
	1979	2794	Forest Dept.
	1981	2500	Karanth & Singh (1981)

TABLE 14
STATE-WISE POPULATION ESTIMATE OF THE BLACKBUCK

State	Population estimate	Major strongholds
Punjab	3500-4000	Abohar in Faridkot district
Haryana	400	Gurgaon district
Uttar Pradesh	1000-2000	Aligarh and Baduan(?) districts
Bihar	50-100	Kaimur plateau
Madhya Pradesh	1500-2000	Karera, Narodehi and Bagdara
Orissa	500-600	Bhetonoi and Balukhand
West Bengal	140	None
Andhra Pradesh	800-1000	Mehboobnagar, Prakasan and West Godavari districts
Karnataka	2000–3000	Rannibennur
Tamil Nadu	1500–1600	Pt. Calimere and Guindy
Maharashtra	4500–5000	Solapur and Ahmednagar districts
Rajasthan	10000–15000 (?)	Dhawa-Doli and Guru -Bishnonian in Jodhpur and Tal Chhaper in Churu
Gujarat	3500 –4000	Velavadar, Sunderpura and Botad

blackbuck exist in significant numbers in less than five national parks and five sanctuaries, and that there are only three protected areas with a population of more than 1,000 animals. They have listed only Velavadar, Pt. Calimere (see Table 13 for contradictory data) and Tal Chhaper. Rannibennur in Karnataka and Vishnoi areas of Rajasthan have been omitted, though for the latter it can be argued that they are not true protected areas as the land does not belong to the Forest Department. However, keeping in mind the fact that the largest populations of blackbuck exist in the Guru-Bishnonian and Dhawa-Doli areas of Jodhpur, such populations cannot be overlooked, no matter what the existing status of their habitat.

Prakash (1990) has expressed the apprehension that with increasing crop damage by ungulates in Jodhpur area, determination among the Vishnoi

community to protect the blackbuck may decline. He has suggested translocating excessive blackbuck to those areas where they were common a few decades ago. The necessity of translocating blackbuck or chinkara *Gazella bennetti* from Vishnoi areas may not arise in the foreseeable future as they (Vishnoi) are still aggressively protective of these species on religious grounds; but this is becoming a major management challenge in areas such as Karera, Rehkuri and Nanaj, where the blackbuck has increased due to effective protection by the Forest Department and not due to any sentimental reasons or religious taboos on killing of antelopes. Crop damage by blackbuck is a major issue in such sanctuaries.

Once the tolerance level of the local agriculturists is crossed, the conservation movement may receive a setback, and in a democratic set up the blackbuck and its defenders may not find many supporters. Instead of delaying any further, the government should evolve a policy on management of locally abundant threatened species. Studies on capture and safe translocating of ungulates should be started and new areas should be identified where the animals could be released.

Although translocating a few hundred blackbuck is not easy, we must try this and other alternative methods before we think in terms of culling the excessive population. Flamand (1989) reported that in Natal, South Africa, the capture unit of the Natal Parks Board caught and translocated close to 4,000 head of game per year. The majority of these animals were ungulates. I suggest that in India also, from total *in situ* protection, the wildlife department should evolve active wildlife management programmes. Translocation of wildlife, from locally abundant populations or to provide genetic vigour to depleted populations, should become an important management tool in future.

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References

Alagar Rajan, S., Balasubramanian, P. & Natarajan, V.A. (in prep.). A study on the population structure of the blackbuck *Antilope cervicapra* Linn. at Pt. Calimere Sanctuary, Tamil Nadu.

Bharucha, E. (in prep.): Behavioural ecology of blackbuck at Rehkuri Blackbuck Sanctuary.

Bhattacharya, T. & Chattopadhyay, B. (1984): A Study on the structure of the social organization of Blackbuck, *Antilope cervicapra* Linne., in Ballavpur Wildlife Sanctuary, West Bengal, India. *Lynx* (Praha) n.s. *22/1984:* 5-10.

Bhattacharya, T. & Chattopadhyay, B. & Chattopadhyay, B.N. (1979): Population status of Indian Blackbuck (*Antilope cervicapra* Linn.) and Spotted Deer (*Axis axis* Erxleben) in Ballavpur Wildlife Sanctuary, West Bengal. *Cheetal. 20 (4)*: 39–47.

Chattopadhyay, B. & Bhattacharya, T. (1986): Basic diurnal activity pattern of Blackbuck, *Antelope cervicapra* Linn. of Ballavpur Wildlife Sanctuary, W.B. and its seasonal variation *J. Bombay nat. Hist. Soc. 83:* 553–561.

Daniel, J.C. (1967): The Pt. Calimere Sanctuary, Madras State. *J. Bombay nat. Hist. Soc. 64:* 513–523.

Dang, H. (1964): Wildlife in Open Country —1. The Black Buck. *Cheetal 7 (1):* 20–24.

Dharmakumarsinhji, K.S. (1978): Velavadar National Park, Gujarat, India. *Tigerpaper 5(1):* 6–8.

Flamand, J.R.B. (1989): Capture and transport methods used for wild ungulates in Natal. pp. 310-319. *In*: Wildlife Conservation and Development in Saudi Arabia. (Eds. Zinada, A.H; Goriup P.D. and Nader, I.A.). Publication No. 3, National Commission for Wildlife Conservation and Development, Riyadh.

Haque, M.N. (1988): Habitat utilization of ungulates of Keoladeo National Park. M. Phil. dissertation, Aligarh Muslim University, Aligarh.

JERDON, T.C. (1874): The mammals of India. John Wheldon, London.

JOHNSON, M.J. (1975): The blackbuck of Pt. Calimere Sanctuary, Tamil Nadu. Population Dynamics and Observation on Behaviour. *Indian Forester 101(1):* 484–494.

JOHNSON, M.J. (1982): Blackbuck census in Pt. Calimere: A Rejoinder. *J. Bombay nat. Hist. Soc. 79:* 186-187.

KARANTH, U. & SINGH, M. (1982): Status Survey Report: Ranebennur Blackbuck Sanctuary. WWF (India), 58 pp.

MANAKADAN, R. & RAHMANI, A.R. (1989):The Rollapadu Wildlife Sanctuary, with special reference to the Great Indian Bustard. *J. Bombay nat. Hist. Soc.86:* 368-380

MARTIN, C. (1977): Status and ecology of the Barasingha (*Cervus duvauceli branderi*) in Kanha National Park (India). *ibid. 74:* 60–132.

MENON, R.K. (1986): The Guindy National Park: Its History and Physiography. *Blackbuck 2(1):* 14–21.

MOHILE, A.M. (1981): Blackbuck at Porbander, Gujarat. *Hornbill 1981(1):* 21.

MUNGALL, E.C. (1978a): The Indian Blackbuck Antelope: A Texas view. Kleberg studies in Natural Resources, No. 3. 184 pp.

MUNGALL, E.C. (1978b): Social development of the young blackbuck antelope (*Antilope cervicapra*). AAZPA Regional Workshop Proceedings *1977-78*: 153-170.

MUNGALL, E.C. (1979): Effect of space limitation on Behaviour expressed by Blackbuck Antelope (*Antilope çervicapra* L. 1758). *Environ. Awaren. 2*: 41-53.

NAIR, S.S. (1976): A population survey and observation on the Behaviour of the blackbuck in the Pt. Calimere Sanctuary, Tamil Nadu. *J. Bombay nat. Hist. Soc. 73:* 304-310.

NATARAJAN, K.N., RAJ, T.S.P.S. & SHAH, C.K. (1978): Blackbuck (*Antilope cervicapra* Linn.) at Pt. Calimere. *J. Bombay nat. Hist. Soc. 75:* 209-211.

NEGINHAL, S.G. (1980): Ecological impact of afforestation at the Rannibennur Blackbuck Sanctuary. *J. Bombay nat. Hist. Soc. 75* (Supplement): 1254-1258.

OZA, G.M. (1978): The endangered existence of the Sunderpura Blackbuck. Reserve: An appeal for conservation. *Environ. Awaren. 1* : 143-148.

PANDEY, R.K., KANDYA, A.K. & KOTWAL, P.C. (1986): Ecological Studies of the Kanha Wildlife National Park, India. (II): Population density and Biomass of Five Common Wild Ungulates. *J. Jpn. For. Soc. 68*(9): 354-360.

PARSHAD, V.R. (1984): Mammalian Fauna of Punjab. *In:* Status of wildlife in Punjab. Eds. A.S. Atwal, S.S. Bains and M.S. Dhindsa. pp. 25-39. Indian Ecol. Soc., Ludhiana.

PATNAIK, S.K., ACHARJYO, L.N. (1985): Wildlife Conservation in Orissa. *Cheetal 27:* 38-44.

PRAKASH, I. (1988): Wildlife, Human-Animal Interaction, and Conservation in the Rajasthan Desert. *In:* Desert Ecology. Ed. I. Prakash. pp. 59-77. Scientific Publishers, Jodhpur, India.

PRAKASH, I. (1990): Dilemma of Ungulate Conservation in the Rajasthan Desert. *In:* Conservation in Developing countries: Problems and Prospects (eds. Daniel, J.C. and Serrao, J.S.). Bombay Natural History Society, Bombay.

PRASAD, N.L.N.S. (1983): Home range size of Blackbuck, *Antilope cervicapra* at Mudumal. Z. Saugetierkunde, *48:* 109-117.

PRASAD, N.L.N.S. (1984): Seasonal changes in the herd structure of Blackbuck. *J. Bombay nat. Hist. Soc. 80:* 549-554.

PRASAD, N.L.N.S. & RAMANA RAO, J.V (1984): Evaluation of habitat structure of blackbuck (*Antilope cervicapra*) in Andhra Pradesh, with special reference to Mudmal and its relevance to behaviour. *Geobios 11:* 17-21.

PRASAD, N.L.N.S. & RAMANA RAO, J.V (1990): Blackbuck conservation in cultivated areas of Andhra Pradesh. *In:* Conservation in Developing countries: Problems and Prospects (eds. Daniel, J.C. and Serrao, J.S.). Bombay Natural History Society, Bombay.

RAHMANI, A.R. & D'SILVA, C. (1984): Sunderpura Blackbuck Reserve. *Hornbill 1984 (3): 29-31.*

RAHMANI, A.R. & MANAKADAN, R. (1989): Return of the Great Indian Bustard in Maharashtra. *Jour. Ecol. Soc. 2:* 19-29.

RAJASINGH, G.J. (1984): A note on the longevity and fertility of the Blackbuck *Antilope cervicapra* Linnaeus. *J. Bombay nat. Hist. Soc. 80:* 632-634.

RAMANA RAO, J.V. & PRASAD, N.L.N.S. (1982): Management and Husbandry of Blackbuck. pp. 75. FAO No. RAPA 53, Bangkok.

RANJITSINH, M.K. (1982a): Ecology and Behaviour of the Indian Blackbuck (*Antilope cervicapra* Linn.) Ph.D. thesis, pp. 290. Saurashtra University, Rajkot, Gujarat.

RANJITSINH, M.K. (1982b): Territorial Behaviour of the Indian Blackbuck (*Antilope cervicapra* Linn., 1758) in Velavadar National Park, Gujarat, *J. Bombay nat. Hist. Soc. 79:* 241-246.

RASHID, M.A. (1977): Census of blackbuck in the Velavadar National Park of Gujarat State. *Cheetal, 19(1):* 3-13.

RODGERS, W.A. & PANWAR, H.S. (1988): Planning a Protected Area Network in India. 2 vols. Wildlife Institute of India, Dehra Dun.

SCHALLER, G.B. (1967): The Deer and the Tiger. Univ. Chicago Press, Chicago.

SHAHI, S.P. (1971): Status of wildlife in Bihar. *Cheetal, 14:* 27-33.

SINGH, G. (1984): Future of Blackbucks in Abohar Sanctuary. *In* Status of Wildlife in Punjab (eds. A.S. Atwal, S.S. Bains & M.S. Dhindsa). pp. 44-46. *Indian Ecol. Soc., Ludhiana.*

SINHA, S.K. & CHHABRA, I.K. (1985): Blackbuck of Gujarat. *Cheetal, 27:* 16-27.

SPILLETT, J.J. (1966): The blackbuck of Sikandra, U.P. *J. Bombay nat. Hist. Soc. 63:* 599-601.

SPILLETT, J.J. (1968): A report on wildlife surveys in South and West India. *J. Bombay nat. Hist. Soc. 65:* 1-46.

PRESENT STATUS OF THE ESTUARINE FLORA OF THE GODAVARI AND THE KRISHNA[1]

P. VENKANNA[2]

(With two text-figures)

While working for the district flora projects (1980-86), the author surveyed extensively the mangrove forests of the Godavari and the Krishna estuaries and collected a good number of mangroves and their associates. The total collections represent 45 species of 37 genera belonging to 26 families (45/37/26). Among them 15/10/8 are true mangroves, 18/18/13 mangrove associates, 10/8/6 halophytes and 2/1/1 sea grasses. The survey resulted in the identification of *Scyphiphora hydrophyllacea* Gaertn. f. (Rubiaceae), a rare mangrove species for the Indian mainland. One very interesting observation is *Prosopis chilensis* (Molina) Stuntz growing in association with *Sonneratia*, *Acanthus* etc.

INTRODUCTION

Mangrove forests are dominant intertidal communities well adapted to colonise the regions where other species are unable to grow. The mangrove zones are highly productive ecosystems which help in carbon, nitrogen and sulphur recycling in nature, besides acting as nurseries for juvenile fish population and providing fire-wood, construction materials and minor timber for fishing boats etc.

Excellent mangrove forests in the Godavari estuary with dense growth of *Avicennia* spp. mixed with other associates of the mangrove zone were recorded during the early part of this century. They cannot be seen anywhere now due to over exploitation by way of fuel auctions by the State Forest Department and other agencies since 1920. Such exploitation was done without understanding the need for special mangrove forest management, which is completely different from the routine forest management of the deciduous forests of India (Rao 1959). Now the extensive mud-flats are over-exposed and heavily mixed with sand, thus becoming unsuitable for the natural regeneration of mangrove species along the two river mouths, besides disturbing the growth and development of fish and other marine species. Poor quality rice cultivation and coconut plantation have been penetrating year after year, together with cutting down of whatever mangrove tree species are available for fuel purposes. Projecting sand creeks with good growth of *Pandanus*, forming closely knitted, extremely strong fortwall-like protective barricades are also being disturbed wherever man has entered with his cultivation. This resulted in the high cyclonic waves which in 1977 devastated the entire False Divi area (Fig. 1) with heavy loss of life and property along the Krishna estuary (Venkanna 1988).

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STUDY AREA

These estuarine zones lie between 15° 43' to 16° 50' N and 80° 45' to 82° 20' E and occupy an area of about 480.84 sq. km (Table 1).

Soils: The soil is entirely river borne alluvial silt and extremely fine mud, forming extensive muddy flats. In certain parts it is mixed with overlying sand, either blown by wind or deposited by waves.

Climate: The regional bioclimate belongs to tropical humid type with a dry season of 5 to 6 months (December to May). The rainfall reaches a maximum in October, due to violent cyclones, which frequently hit the east coast of India, bringing torrential rains exceeding 200 mm in a few hours. The average rainfall is about 1000 mm/year. The mean annual temperatures during the hottest and coldest months are 28°C and 19°C respectively. Salinity levels of more than 40% seen in the mangrove waters between May and July, fall to 5% between October and December.

Earlier literature: The works of Roxburgh (1795-1819), Hooker (1872-1897) and Gamble (1915-1936) are the most important amongst the few which dealt with the coastal plants of the area. Later Venkateswarlu (1944, 1946), Rao (1959), Wagh (1960), Sidhu (1963), Raju (1968), Rao and Sastry (1972, 1974), Sastry and Rao (1973), Blasco (1975), Chapman (1976), Rao *et al.* (1985, 1986) and Venkanna (1988) have given a comprehensive ac-

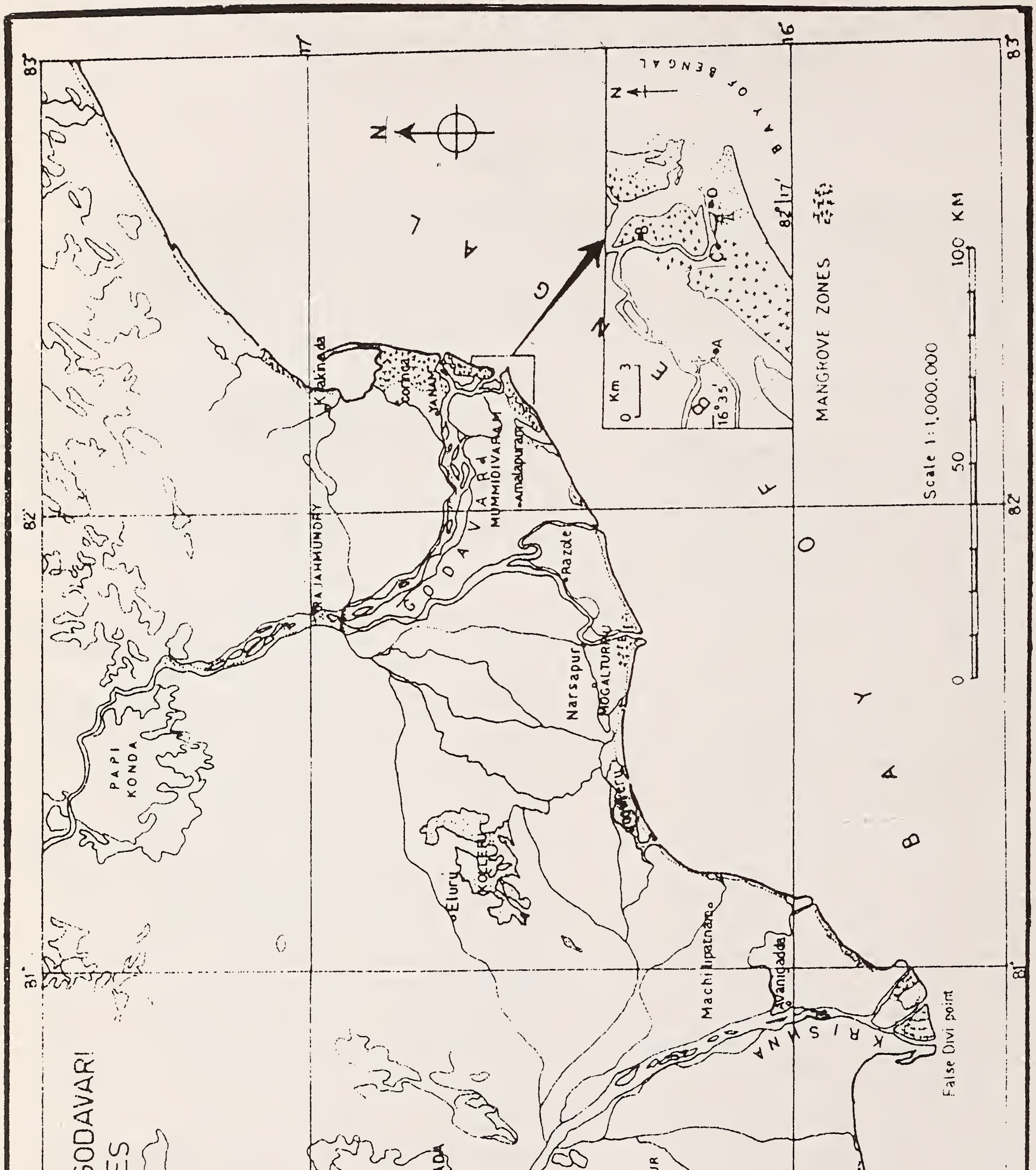

Fig. 1. Distribution of mangroves in Krishna and Godavari estuaries
Inset: present locality of *Scyphiphora hydrophyllacea*, A. Kandikuppa; B. Balusuthippa; C. Kothapalem;
D. Sacramento light house.

TABLE 1
DETAILS OF AREA COVERED BY MANGROVE FORESTS*

Zone	Forest Area	Total Forest Area (sq. km)
Godavari Estuary:		
Coringa	Coringa	42.42
	Coringa extension	194.67
Balusutippa	Masanitippa	10.89
	Balusutippa	4.75
	Rathikalva	20.49
	Kothapalem	0.50
Pandi	Kandikuppa	38.02
	Matlatippa	4.45
Krishna Estuary:		
Yela chettu dibba palem	Yela chettu dibba palem	37.14
	Yela chettu dibba palem extension	6.10
Nachugunta	Nachugunta	60.65
	Nachugunta extension	8.76
Sorlagondi	Sorlagondi	25.09
	Sorlagondi extension	26.91
		480.84

*Data from Andhra Pradesh Forest Department.

count on the mangroves of these estuaries.

The present work gives data on composition besides enumeration of flora.

VEGETATION

The general pattern of the vegetation indicates a sort of zonal distribution among the species of the mangrove forests. The spiny *Acanthus ilicifolius* L., and the tall grass *Myriostachya wightiana* (Nees ex Steud.) Hk. f. often mixed with *Clerodendrum inerme* Gaertn. form dense thickets, lining the network of canals. These are followed by the pioneer species of the muddy flats, namely *Avicennia marina* (Forssk.) Vierh., *A. officinalis* L., which pave the way for the species of *Rhizophora*, *Bruguiera*, *Ceriops*, *Sonneratia* and a few others. *Avicennia* species form the main component of the vegetation, towards the land side with comparatively shallower water usually covered by the species of *Lumnitzera*, *Aegiceras*, *Excoecaria* etc.

TABLE 2
BRIEF ANALYSIS OF ESTUARINE FLORA UNDER DIFFERENT GROUPS

Group	Family	Genera	Species
True mangroves	8	10	15
Mangrove associates	13	18	18
Halophytes	6	8	10
Sea grasses	1	1	2
Total	26	37	45

Near Coringa the network of canals is lined by *Acanthus*, *Myriostachya* and *Hibiscus tiliaceus* L., a Malvaceous shrub, *Impomoea violacea* L., *Caesalpinia nuga* Ait., *Derris trifoliata* Lour., etc. are found, except this locality nowhere in India *Hibiscus tiliaceus* L. is an element with mangroves.

Similar to the Bengal coast the three species of *Avicennia* have been recorded. Finally the much exposed regions are occupied by the halophytic species like *Suaeda*, *Salicornia*, *Arthrocnemum*, *Cressa*, *Heliotropium*, *Aeluropus* etc.

Very interesting phytogeographical observations were made on these mangrove forests, at Nachugunta of Krishna estuaries. *Prosopis chilensis* (Molina) Stuntz and *Mimosa polyancistra* Benth. grow in association with *Sonneratia apetala* Buch.-Ham. and *Myriostachya wightiana* (Nees ex Steud.) Hk. f. in the islands which are nearer to the sea. *Suaeda monoica* Forssk. ex Gmel. grows unusually tall, nearly 1-2 m. at Yela chettu dibba palem towards inland. Pure stands of *Rhizophora apiculata* Bl. were also observed along the Krishna river bank at Yela chettu dibba palem. Banks of Krishna river at Nagayalanka-Yela chettu dibba palem were fully covered with *Acacia nilotica* (L.) Wild. ex Del. spp. *indica* (Benth.) Brenan. Near Coringa of the

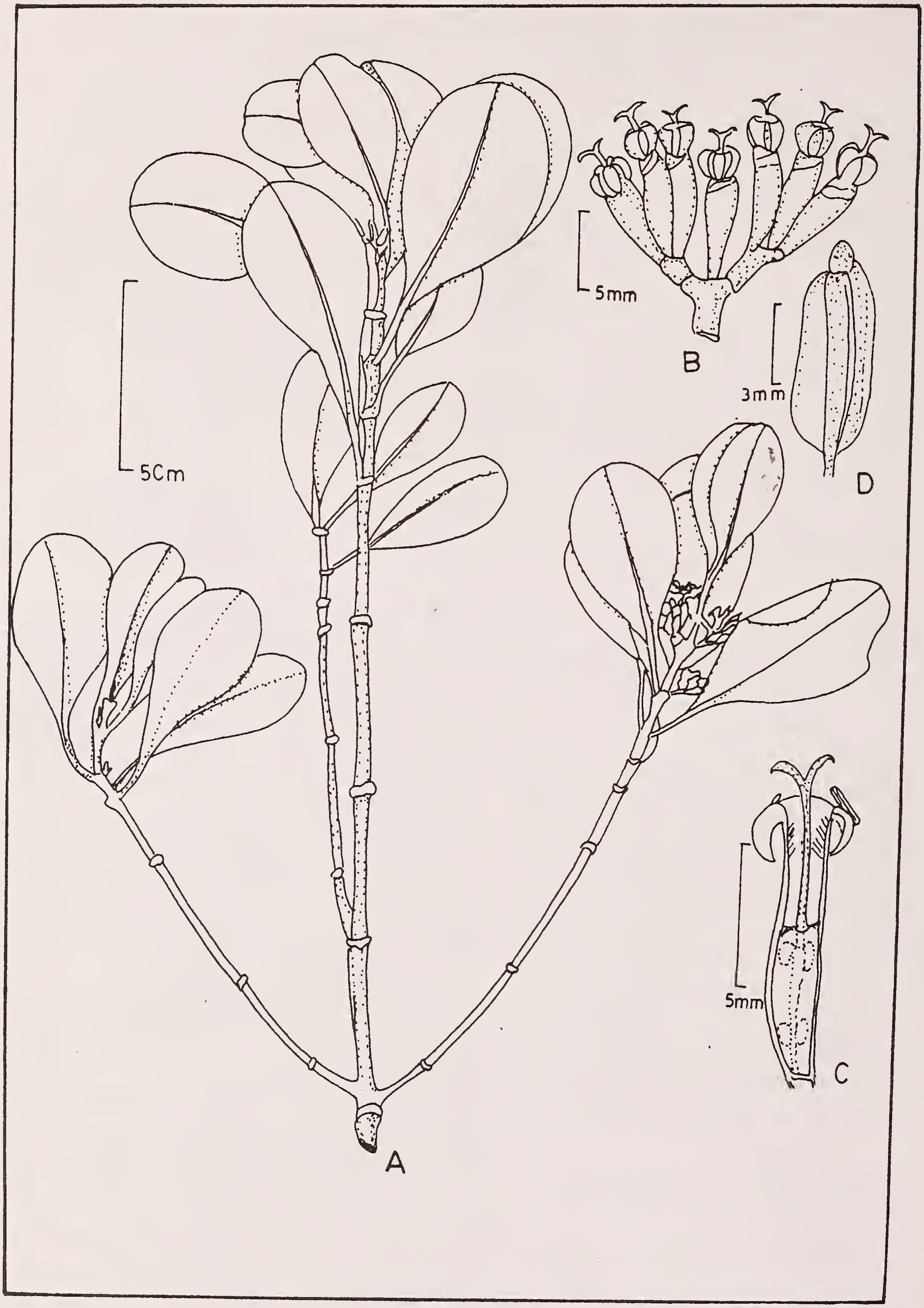

Fig. 2. *Scyphiphora hydrophyllacea*
A. Twig; B. Inflorescence; C. Flower L.S.; D. Fruit.

TABLE 3
THE DISTRIBUTION OF THE SPECIES IN DIFFERENT GROUPS

Species	Estuary Godavari	Krishna
True mangroves		
Aegialitis rotundifolia Roxb.	–	+
Aegiceras corniculatum (L.) Bl.	+	+
Avicennia alba Bl.	+	+
Avicennia marina (Forssk.) Vierh.	+	+
Avicennia officinalis L.	+	+
Bruguiera cylindrica (L.) Bl.	–	+
Bruguiera gymnorrhiza (L.) Lam.	+	+
Ceriops decandra (Griff.) Ding Hou	+	+
Lumnitzera racemosa Willd.	+	+
Rhizophora apiculata Bl.	+	+
Rhizophora mucronata Lam.	–	+
Scyphiphora hydrophyllacea Gaertn. f	+	–
Sonneratia apetala Buch.-Ham.	+	+
Sonneratia caseolaris (L.) Engl.	+	–
Xylocarpus granatum Koen.	+	+
Mangrove associates:		
Acanthus ilicifolius L.	+	+
Barringtonia acutangula (L.) Gaertn.	+	–
Caesalpinia nuga Ait.	+	+
Clerodendrum inerme Gaertn.	+	+
Dalbergia horrida (Dennst.) Mabb.	+	+
Derris trifoliata Lour.	+	+
Excoecaria agallocha L.	+	+
Hibiscus tiliaceus L.	+	–
Ipomoea violacea L.	+	–
Mimosa polyancistra Benth.	–	+
Myriostachya wightiana (Nees ex Steud.) Hk.f.	+	+
Prosopis chilensis (Molina) Stuntz	–	+
Proterasia coarctata (Roxb.) Takeoka	+	–
Salvadora persica L.	–	+
Sarcolobus carinatus Wall.	+	+
Stictocardia tiliifolia (Desr.) Hall.f.	+	–
Tamarix troupii Hole	+	+
Thespesia populnea Cav.	+	–
Halophytes:		
Aeluropus lagopoides (L.) Trin.	+	+
Arthrocnemum indicum (Willd.) Moq.	+	+
Cressa cretica L.	+	+
Fimbristylis cymosa R. Br.	+	+
Heliotropium curassavicum L.	+	+
Salicornia brachiata Roxb.	+	+
Sesuvium portulacastrum L.	+	+
Suaeda maritima (L.) Dummort	+	+
Suaeda monoica Forssk.	+	+
Suaeda nudiflora Moq.	–	+
Sea grasses:		
Halophila beccarii Asch.	+	+
Halophila ovalis (R. Br.) Hk.f.	+	+

\+ presence – absence of the species

Godavari estuary *Barringtonia acutangula* (L.) Gaertn. lines the creeks in association with *Avicennia marina* (Forssk.) Vierh. and *A. officinalis* L.

In raised sandy areas near the sea coast where tree species of mangrove do not flourish well, plantations of *Casuarina equisetifolia* Forst. & Forst. f. and *Eucalyptus* species have been very successfully reared. Along the muddy flats, sea grasses like *Halophila ovalis* (R. Br.) Hk. f. and *H. beccarii* Asch. have been recorded from both the estuaries.

Scyphiphora hydrophyllacea Gaertn. f. (Rubiaceae) (Fig. 2), which is rare on the Indian mainland, has been recorded for the first time along the creeks near Sacramento light house of Godavari estuary. This monotypic species is associated mostly with *Lumnitzera*, *Ceriops* and *Aegiceras*.

In the following enumeration, the species are arranged alphabetically, the botanical name followed by family, vernacular name, locality with field number (collected by author) and notes. The specimens have been deposited at the Andhra University Botany Department Herbarium (AUH) (yet to be placed in Index Herbarium), Waltair. Floristic analysis (Table 2) and species in each group (Table 3) are also recorded. Abbreviation used in the text is) R.F.=Reserve Forests.

SPECIES ENUMERATION

Acanthus ilicifolius L. Acanthaceae. Alchi. Sacramento light house, Kandikuppa R.F., 1599; Bandar Fort R.F., 5070 and 5353; China gollapalem, 1577 and 5109. Common along marshy creeks.

Aegialitis rotundifolia Roxb. Plumbaginaceae. Yeti putchcha. Observed at Nachugunta R.F. associated with *Lumnitzera*, *Aegiceras* etc.

Aegiceras corniculatum (L.) Blanco Myrsinaceae. Guggilam. Kothapalem, 3, Sacramento light house, 1596; Nachugunta R.F., 5078; Bandar Fort R.F., 5066 and 5354; China gollapalem, 1578 and 5107. Common, close to the backwater edges.

Aeluropus lagopoides (L.) Trin. ex Thw. Poaceae. Puvvu gaddi. Masanitippa, 29; Bandar Fort R.F., 5059. Common along open saline beds.

Arthrocnemum indicum (Willd.) Moq. Chenopodiaceae. Ela kura. Masanitippa, 27; Nachugunta R.F., 5072; Bandar Fort R.F., 5061; China gollapalem, 5768. Frequent along open saline beds.

Avicennia alba Bl. Avicenniaceae. Vilava mada. Sacramento light house, 1591; China gollapalem, 1579; Yela chettu dibba palem R.F., 5614. Found very few populations, associated with *Sonneratia* and *Rhizophora* spp.

Avicennia marina (Forssk.) Vierh. Avicenniaceae. Tella mada. Sacramento light house, 7; Turputalla, 48; Yela chettu dibba palem R.F., 5079 and 5765; Bandar Fort R.F., 5355 and 5356. Very common along the backwaters.

Avicennia officinalis L. Avicenniaceae. Nalla mada. Sacramento light house, 1590; Yela chettu dibba palem R.F., 5612; China gollapalem, 5102. Very common along the backwater creeks of Godavari estuary and rare along the Krishna estuary.

Barringtonia acutangula (L.) Gaertn. Barringtoniaceae. Tarepu. Frequently observed along the inner creeks of Coringa and Matlapalem areas of Godavari estuary.

Bruguiera cylindrica (L.) Bl. Rhizophoraceae. Vurudu. Yela chettu dibba palem R.F., 5607. Found only along the Krishna estuary.

Bruguiera gymnorrhiza (L.) Savi. Rhizophoraceae. Thuddu ponna. Sacramento light house, 11; Kothapalem, 1581; Yela chettu dibba palem R.F., 5606. Common along the creeks with well formed knee-roots.

Caesalpinia nuga Ait. Caesalpiniaceae. Mulla theega. Yela chettu dibba palem R.F., 5608. Also observed at Coringa.

Ceriops decandra (Griff.). Ding Hou Rhizophoraceae. Gatheru. Kothapalem, 2; Masanitippa, 25; China gollapalem, 1582; Sacramento light house, 1592; Yela chettu dibba palem R.F., 5610. Found close to the backwater canals, just behind the *Rhizophora* belt.

Clerodendrum inerme (L.) Gaertn. Verbenaceae. Eti pisiniki. Kothapalem, 10; Perupalem, 1584; Yela chettu dibba palem R.F., 5603; Nachugunta R.F., 5075; Bandar Fort R.F., 5067. Common along the creeks.

Cressa cretica L. Convolvulaceae. Uppu mokka. Balusuthippa, 56; Nachugunta R.F., 5074. Common in open saline beds.

Dalbergia horrida (Dennst.) Mabb. Fabaceae. Chillangi. Masanitippa, 32; Yela chettu dibba palem R.F., 5604; Bandar Fort R.F., 5132 and 5366; China gollapalem, 5106. Common spiny shrub in the interior component of mangrove scrub.

Derris trifoliata Lour. Fabaceae. Nalla theega. Masanitippa, 30; Yela chettu dibba palem R.F., 5605; China gollapalem, 1576 and 5101. Common twiner, found along the inner regions.

Excoecaria agallocha L. Euphorbiaceae. Thilla. Kothapalem, 1; Perupalem, 1587; Sacramento light house, 1600; Yela chettu dibba palem R.F., 5601; Nachugunta R.F., 5077; Bandar Fort R.F., 5069. Most common in these estuaries.

Fimbristylis cymosa R. Br. Cyperaceae. Commonly observed in the marshy creeks along with Proteracea.

Halophila beccarii Asch. Hydrocharitaceae. Yela chettu dibba palem R.F., 6118 and also observed along the Pandi creek. Rare in the muddy coast in mangrove zones. The present report extends its distribution from south to the north along the east coast.

Halophila ovalis (R.Br.) Hk.f. Hydrocharitaceae. Yela chettu dibba palem R.F., 6117 and also observed along the pandi creek. Abundant in muddy flats in mangrove zones.

Heliotropium curassavicum L. Boraginaceae. Nela golividi. Etimoga 5081. Common in open saline beds.

Hibiscus tiliaceus L. Malvaceae. Konda prathi. Very common along the creeks near Coringa.

Ipomoea violacea L. Convolvulaceae. Gaju theega. Matlapalem, 6317. Very abundant along the thickets near Coringa and its surrounding regions.

Lumnitzera racemosa Willd. Combretaceae. Thanduga. Masanitippa, 1597; China gollapalem, 1583; Yela chettu dibba palem R.F., 5616; Bandar Fort R.F., 5068 and 5133. Commonly associated with *Ceriops* and *Aegiceras*.

Mimosa polyancistra Benth. Mimosaceae. Pichu regu. Nachugunta R.F., 5557. Associated with *Aegialitis*. The first report of this species in the estuaries.

Myriostachya wightiana (Nees ex Steud.) Hk.f. Poaceae. Ela Kara, Kikkisa. Perupalem, 1586; Yela chettu dibba palem, 5609; China gollapalem, 5110. Common along the edges of the creeks.

Prosopis chilensis (Molina) Stuntz Mimosaceae. Mulla thumma. Nachugunta R.F., 5445. Gregariously growing along the estuaries associated with *Sonneratia* spp. This report confirms its occurrence at Krishna estuary along with mangroves (Rao 1959).

Proterasia coarctata (Roxb.) Takeoka. Poaceae. Kothapalem, 14. Very rare grass observed along with *Fimbristylis cymosa* at Coringa.

Rhizophora apiculata Bl. Rhizophoraceae. Kaki ponna. Sacramento light house, 12; Kothapalem, 1595; Yela chettu dibba palem R.F., 5112; Perupalem, 5770. Buttressed by long stilt roots (knee roots) forming the outermost fringe of the mangrove vegetation towards the sea. The plant remains on the stilt roots after the main stem dies.

The author observed at Perupalem (l.c.) an old, large single tree with huge stilt roots. The bark of these roots was being eaten by goats, though it contains a large amount of tanins.

Rhizophora mucronata Poir. Rhizophoraceae. Uppu ponna. Yela chettu dibba palem R.F., 5602. Rare. Associated with *R. apiculata*; stilt roots rather vertical; spread of crown less than that of *R. apiculata*. Only observed along the Krishna estuary.

Salicornia brachiata Roxb. Chenopodiaceae. Sitamma vari dubbu. Perupalem, 1585. Found extensively along the open saline beds.

Salvadora persica L. Salvadoraceae. Pedavara gogu. Yela chettu dibba palem village, 5763. A typical plant of saline soils along the coast or in backwaters above mangrove forests.

Sarcolobus carinatus Wall. Asclepiadaceae. Pala boddu theega. Kothapalem, 5; China gollapalem, 1575; Yela chettu dibba palem R.F., 5611. Common twiner on *Dalbergia* and *Clerodendrum*.

Scyphiphora hydrophyllacea Gaertn. f. Rubiaceae (Fig. 2). Nara thanduga. Sacramento light house (the area presently preserved by A.P. Forest Dept. Fig. 1 inset D), 51 and 1598. This is the first report of this taxon from the Indian mainland. Rare in mainland abundant in Andaman islands. (Thothathri 1962).

Sesuvium portulacastrum (L.) L. Aizoaceae. Thikka kura, Adavi baddu. Masanitippa, 41; Sacramento light house, 52 and 1593; Yela chettu dibba palem R.F., 5613; Bandar Fort R.F., 5565. Commonly found along the muddy flats and the banks of the creeks.

Sonneratia apetala Buch.-Ham. Sonneratiaceae. Pedda kalinga. Yela chettu dibba palem R.F., 5615; China gollapalem, 5108. The species grows in association with *Myriostachya* and *Prosopis chilensis*.

Sonneratia caseolaris (L.) Engl. Sonneratiaceae. China kalinga. Masanitippa, 31. Rarely found at Godavari estuary.

Stictocardia tiliifolia (Desr.) Hall. f. Convolvulaceae. Observed at Coringa. Straggler on mangrove thickets.

Suaeda maritima (L.) Dumont. Chenopodiaceae. Ela Kura. Kothapalem, 6; Sacramento light house, 1589, Yela chittu dibba palem, 5766; Nachugunta R.F., 5076; Bandar Fort R.F., 5062. Appears as pure stands along open saline beds.

Suaeda monoica Forssk. ex Gmel. Chenopodiaceae. Goliguru dubbu. Masanitippa, 26; Nachugunta R.F., 5071. Pure stands reaching nearly 1-2 m are seen in Yela chettu dibba palem R.F., towards the land.

Suaeda nudiflora Moq. Chenopodiaceae. Jilugu. Yela chettu dibba palem R.F., 5617. Rare in comparison with the other 2 species.

Tamarix troupii Hole. Tamaricaceae. Palligi. Yela chettu dibba palem, 5767. Found in the Krishna river bed nearer to the sea and also at Matlapalem of the Godavari estuary.

Thespesia populnea (L.) Soland ex Correa. Malvaceae. Ganga ravi. Kothapalem, 9. Found only at the Godavari estuary, very abundant at Coringa.

Xylocarpus granatum Koen. Meliaceae. Chenuga. Sacramento light house, 13; China gollapalem, 5769. Rare, a few individuals associated with *Avicennia* spp.

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REFERENCES

BLASCO, F. (1975): The mangroves of India. Pondicherry.

CHAPMAN, V.J. (1976): Mangrove vegetation. Vaduz.

GAMBLE, J.S. (1915-36): Flora of the Presidency Madras (3 vols.), London.

HOOKER, J.D. (1872-97): The Flora of British India (7 vols.), London.

RAJU, D.C.S. (1968): The vegetation of West Godavari – A study of Tropical delta. *Proc. Symp. Recent Adv. Trop. Ecol.* 348-358.

RAO, R.S. (1959): Observations on the mangrove vegetation of

the Godavari Estuary. *Proc. Mangrove Symp.* 36-44.

Rao, R.S., Lakshminarayana, K. & Venkanna, P. (1985): Mangrove forests of the Godavari and the Krishna estuaries of Andhra Pradesh. The urgent need for their development and conservation. *In:* Bhosale, L.J. (ed.). The mangroves: 338-340.

Rao, R.S. Venkanna, P. & Appi reddy, T. (1986): Flora of West Godavari district, Andhra Pradesh. Meerut.

Rao, T.A. & Sastry, A.R.K. (1972): An ecological approach towards classification of coastal vegetation in India. *Indian Forester 98:* 594-607.

Rao, T.A. & Sastry, A.R.K. (1974): Classification and distribution of Indian Mangroves. ibid. *100: 438-452.*

Roxburgh, W. (1795-1819): Plants of the coast of Coramandel (3 vols.). London.

Sastry, A.R.K. & Rao, T.A. (1973): Studies on the flora and vegetation of coastal Andhra Pradesh, India. *Bull. bot. surv. Ind. 15 (1 & 2):* 92-107.

Sidhu, S.S. (1963): Studies on the mangroves of India – I. East Godavari region. *Indian Forester 89 (5):* 337-351.

Thothathri, K. (1962): Contribution to the Flora of the Andamans and Nicobar Islands. *Bull. bot. Surv. Ind. 4 (1-4):* 281-296.

Venkanna, P. (1988): Flora of Krishna district, Andhra Pradesh. Ph.D. Thesis. Andhra University, Waltair (Unpublished).

Venkateswarlu, V. (1944): The esturial flora of Godavari. *J. Bombay nat. Hist. Soc. 44:* 431-435.

Venkaleswarlu, V. (1946): A note on the estuarine flora of the Krishna. *Sci. & Cult. 12:* 296.

Wagh, S.K. (1960): Studies on the Flora of Andhra State. Ph.D. Thesis. Bombay University, Bombay (Unpublished).

FLIGHT SCHEDULES OF WINGED TERMITES (INSECTA: ISOPTERA) IN DOON VALLEY, UTTAR PRADESH[1]

M.L. THAKUR[2]

(*With two text-figures*)

The phenomenon of swarming in termites is an annual feature but precise information on their flight schedules and circumstances associated with the phenomenon is generally lacking for the great majority of Indian species. Significant contributions on this aspect have been made by Mathur and Sen-Sarma (1959, 1960, 1962), Sen-Sarma *et al.* (1975), Thakur (1978, 1985), Thakur and Sen-Sarma (1981) and Roonwal (1976, 1983).

INTRODUCTION

I have been actively engaged in termite research for well over a quarter of a century and have been collecting information on the swarming behaviour and the associated problems in the Doon Valley, Uttar Pradesh. This paper summarises the information on this important aspect of behavioural ecology of termites collected over the years, for 21 species. Information available in literature has also been incorporated.

SWARMING CHARACTERISTICS

The Doon Valley which comprises the whole of Dehradun district, is an open valley and lies between 29° 39' and 30° 31' N and 77° 34' and 78° 20'E. The valley is somewhat like a parallelogram in shape and is about 80 km in length, with an average width of about 7 km, widening in the eastern dun region. The valley is bounded by the outer ranges of the Himalaya on the north, by the Siwalik hills on the south and by the rivers Ganga and Yamuna on the eastern and western boundaries. The terrain is uneven. The climate is sub-tropical and humid during the greater part of the year, except during the dry hot months of May and June. Average annual rainfall is about 2000 mm. The soil in general is 'dun alluvium', and is generally clayey, tending to be loam, except in the hilly and sub-montane tract, and supports rich and luxurious vegetation, with large tracts of valuable sal forests and many other timber species and bamboos.

Family KALOTERMITIDAE

1. *Neotermes bosei* Snyder is a common species in northern India and has been recorded from dead branches of trees of several species. Emergence of alates in Doon Valley occurs late in the evening after sunset from the last week of January (26th) to the first week of July (4th), but major swarmings take place during early April to early June. Emergence is intermittent and in small batches (Roonwal and Sen-Sarma 1955, Mathur and Sen-Sarma 1959, Sen-Sarma *et al.* 1975). In eastern India (Kalimpong, North Bengal), alates of this species have been collected during November-December.

2. *Neotermes megaocculatus megaocculatus* Roonwal and Sen-Sarma has been recorded from dead branches of *Mangifera indica* in Doon Valley. No emergence record is available in Doon Valley; however, in the Kumaon hills, it has been recorded in the last week of May.

Family RHINOTERMITIDAE

3. *Heterotermes indicola* (Wasmann) is a major wood destroying termite in northern India (above 20° N, going up to 2500 m in the Himalayan region). It has also been recorded from many localities in Pakistan and parts of Afghanistan. The species swarms from the first week of July to the third week of August. In Doon Valley, the swarming has been recorded at night between 2100-2400 hrs in mid July on rainy days, particularly when the rain has continued for an hour or so (Sen-Sarma *et al.* 1975). However at Jodhpur, Roonwal (1976) has reported its swarming between 2000-2030 hrs in July-August. Observations recorded in Doon Valley and in most of the other localities in India indicate that this species swarms only during the night. However in Bombay, Assmuth (1913) recorded the swarming 'in the morning' at 0800 hrs or a little later, during the first showers of the monsoon. In Punjab, Arora and Gilotra (1960) recorded the

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swarming during mid August, when it was actually raining.

4. *Coptotermes heimi* (Wasmann) is one of the most widely distributed and major wood-destroying termite species in India, occurring throughout India and Pakistan. It has also been introduced into other countries of southeast Asia. This species usually swarms at dusk and in the early part of the night from January to August after heavy rain showers (Thakur 1985). In the Doon Valley its swarming occurs in June and July after heavy showers (Mathur and Sen-Sarma 1959). In Rajasthan (Jodhpur), this species has been reported to swarm even late at night after 2100 hrs and occasionally when it is drizzling (Roonwal 1976, 1983). At Coimbatore, Thakur (1985) has recorded the swarms of this species from the third week (1830-1930 hrs) of January to the last week of February, when the weather is quite dry. He has also reported synchronized flight schedules exactly on the same date (5 and 23 February 1980 and 1983) and at the same time (1845 hrs) from two different colonies situated *c.* 18 km apart.

Specific records of swarming in this species are available in literature within its entire range of distribution. Depending upon the local meteorological conditions in a locality, this species seems to swarm, in south India (Coimbatore, approx. 11 ° N.) from 3rd week of January to the last week of February (*vide supra*), in the warmer and more humid parts of Bombay, Orissa and West Bengal (approx. 19-22° N.) from March to May and in the drier parts of Haryana, Punjab, Rajasthan and Uttar Pradesh (26°5'N) on dry days during summer months from May (2nd half) to August. Swarming occurs intermittently in small batches.

Family Stylotermitidae

5. *Stylotermes dunensis* Thakur is a rare wood-inhabiting termite known only from Dehradun in the Doon Valley. This species has been collected from avenue trees such as *Acer oblongum, Mangifera indica*, etc. Swarming in nature has not been observed. However, winged alates have been collected from infested logs during the second half of July in the laboratory.

Family Macrotermitidae

6. *Odontotermes assmuthi* Holmgren is very widely distributed almost all over India and swarms during the greater part of the year from the last week of February to the middle of December. In Doon Valley, this species has two flight periods, i.e. winter flight season from second half of February to early March and summer flight season in June, usually in the second half of the month. During the summer flight season, it usually swarms at 1630 hrs on bright sunny days preceded by heavy shower of rain (Sen-Sarma 1962). Occasionally, its swarms have also been recorded in the morning (0700-0830 hrs) on cloudy days or even during light drizzle (Thakur 1978, 1985). During winter flight season, winged alates have been collected at light. Elsewhere, at Coimbatore, the swarms of this species have been recorded at dusk to early in the night (1830-1930 hrs) in the second half of October, invariably 6-12 hours after rain (Thakur 1985). These records of flight schedules show that there is no rigid time schedule for swarming in this species. It may swarm in the early morning (0700-0830 hrs), late in the afternoon at 1630 hrs or at dusk (1830-1930 hrs).

7. *Odontotermes bhagwatii* Chatterjee and Thakur. This species occurs in Himachal Pradesh, Jammu and Kashmir, Punjab, Uttar Pradesh (Doon Valley) and Karnataka. In Doon Valley, this species swarms at dusk (1830-1900 hrs) during June-August, from small holes in the ground after heavy rains. Specific dates of swarmings as available in literature are: 4 August 1912, 19 July 1918, 29 July 1940, 6 July 1973 and 11 June 1984.

8. *Odontotermes dehraduni* Snyder has been recorded from North India (Dehra Dun, Delhi, Jodhpur) and Pakistan. This species is known from imago caste only. Swarming is reported to occur in the evening (1830-2030 hrs) from the last week of June to the end of September, from small holes in the grounds after a heavy shower. The alates are attracted towards light in large numbers. In Doon Valley, it swarms during the last week of June almost to the end of July.

9. *Odontotermes distans* Holmgren and Holmgren. This species is very widely distributed throughout India, Pakistan, Bangladesh, Bhutan and Burma. In India, this species is more common in northern and eastern India, inhabiting submontane areas in the Himalayan ranges, reaching up to 2100 m.

It swarms during the greater part of the year, from the middle of February to first week of Decem-

ber. In the Doon Valley, like *O. assmuthi*, this species has two flight seasons. It swarms primarily in the afternoon (1600-1630 hrs) to dusk in the last week of February to early April (winter flight season) and again in the last week (25th) of July at about 1930-2030 hrs (summer flight season). The swarming is usually preceded by rain (6-12 hours) and is, at times, also followed by rain (3-6 hours). Another interesting feature recorded by the author is the synchronization of flight schedules on the same dates (26 February 1970 and 1973) in the New Forest Estate (Dehra Dun). Elsewhere, its swarms have been recorded at dusk in February-March (West Bengal, eastern India), August (Jodhpur, Rajasthan) and from middle of October to the third week of November (Coimbatore, Tamil Nadu).

10. *Odontotermes indicus* Thakur is also very widely distributed throughout India, except eastern India. Swarming has been recorded in June and September (Orissa). In Doon Valley, this species swarms during monsoon months of July and August. Swarming is crepuscular or nocturnal, usually beginning at dusk or a little later and continuing sometimes throughout the night. At times, the swarming occurs even when it is drizzling. The alates come out simultaneously from holes at different places in the ground.

11. *Odontotermes microdentatus* Roonwal and Sen-Sarma. This species is a mound building termite, occurring in the greater part of India, building low dome shaped conical or cylindrical mounds, sometimes with large vertical buttresses (Sen-Sarma *et al.* 1975). In Doon Valley, this species swarms at night (2300 hrs) during the second half of June (Aggarwal 1975).

12. *Odontotermes obesus* (Rambur) is a very widely distributed species in south-east Asia, occurring throughout India, up to 2000 m in the Himalaya (except very cold regions), Pakistan, Bangladesh and Burma. This species swarms from May to end of November. In Doon Valley, the swarming takes place during June and July. The swarming begins with the onset of monsoon in June. It begins at dusk or at night (1830-2200 hrs) and continues sometimes throughout the night usually after heavy showers. Flights also occur when rain is actually falling. Some actual records of swarming schedules as available in literature within India are as follows: May (1st week) at Almora (Kumaon Hills, Uttar Pradesh), June-July (Doon Valley), Bhopal (Madhya Pradesh), July-August (Jodhpur, Rajasthan), October (Cochin, Kerala) and last week of October to end of November (Coimbatore, Tamil Nadu).

13. *Microtermes obesi* Holmgren. This species occurs widely in south and southeast Asia (Pakistan, India, Bangladesh, Sri Lanka, Burma and Thailand). Swarming occurs mostly from early July to early August in northern India, but alates have been collected from the nest in April-May-June (Roonwal 1970, Roonwal and Verma 1977). In Doon Valley (Dehra Dun), this species swarms late in the afternoon (1300-1530 hrs) during July. Elsewhere (Jodhpur, Rajasthan), it has been found to swarm early in the day (1030-1330 hrs).

14. *Microtermes unicolar* Snyder is found in Pakistan, northwestern India and Bangladesh. It occurs commonly in pouches in the outer region of mounds of *Odontotermes* and under wood debris in forest areas. Swarming occurs in summer and rainy months from April to August. In Doon Valley, swarms have been recorded at night (1900-2100 hrs) in the months of June, usually after rainfall.

Family TERMITIDAE

15. *Speculitermes cyclops* Wasmann is widely distributed in India, from eastern Rajasthan, Uttar Pradesh, Madhya Pradesh (up to 1050 m altitude, Pachmarhi), Maharashtra and some parts of Karnataka (Coorg). The species occurs in well wooded or semi-open humid forest vegetation, where the soil retains higher percentage of moisture and comparatively moderate temperature. Precise swarming records are lacking in literature; however, the alates have been collected from the nest, from the last week of May to third week of June at Dehradun. In Bombay, Assmuth (1913) is reported to have collected imago caste on 12 May.

16. *Euhamitermes lighti* Snyder is known only from Doon Valley. It belongs to a group of subterranean humus feeding termites, found only a few centimetres below well drained amorphous land. Actual swarming records are lacking in literature, but fully matured alates have been encountered in the field from 2nd week of May to end of June. It may, therefore, be surmised that this species swarms some time during the rainy months of June and July.

17. *Eremotermes dehraduni* Roonwal and Sen-Sarma. This species is also known only from the

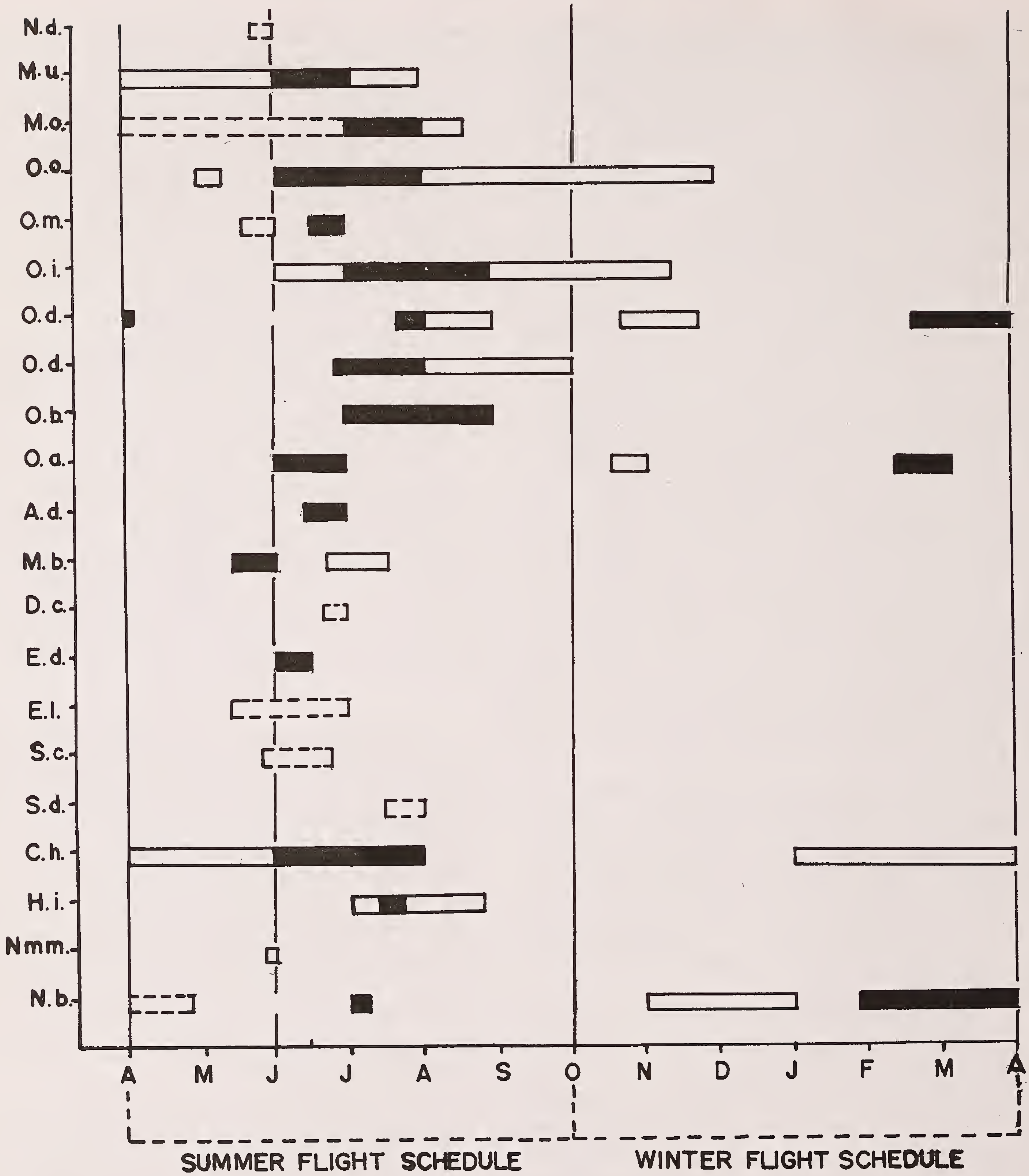

Fig. 1. Swarming schedules of termites in Doon Valley. Hollow bars: show swarming periods of species at other localities within the entire range of their distribution. Solid bars: show swarming periods in Doon Valley.
N.b. *Neotermes bosei*; N.m.m. *Neotermes megaoculatus megaoculatus*; H.i. *Heterotermes indicola*; C.h. *Coptotermes heimi*; S.d. *Stylotermes dunensis*; S.C. *Speculitermes cyclops*; E.l. *Euhamitermes lighti*; E.d. *Eremotermes dehraduni*; D.c. *Doonitermes capillosus*; M.b. *Microcerotermes beesoni*; A.d. *Angulitermes dehraensis*; O.a. *Odontotermes assmuthi*; O.b. *Odontotermes bhagwatii*; O.i. *Odontotermes indicus*; O.m. *Odontotermes microdentatus*; O.o. *Odontotermes obesus*; M.o. *Microtermes obesi*; M.u. *Microtermes unicolor*; N.d. *Nasutitermes dunensis*.

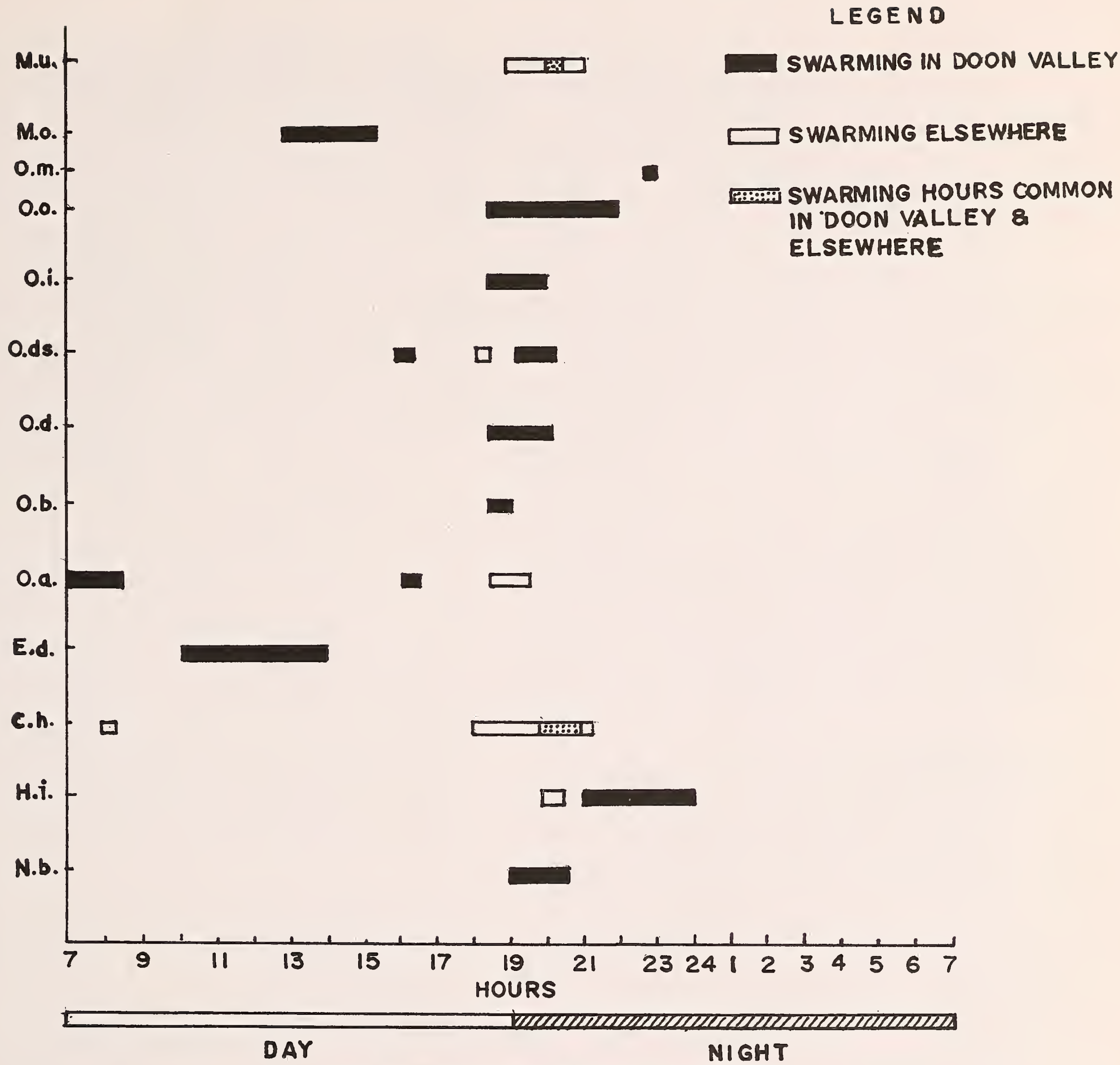

Fig. 2. Swarming hours of termites in Doon Valley

Doon Valley. It has been collected from wet areas in the valley. The swarming in this species occurs in the first half of June during bright sunshine from 1000 to 1400 hrs from small holes in the ground, usually after a shower of rain.

18. *Doonitermes capillosus* Chatterjee and Thakur. This species lives in medium sized communities in the sal forests in the Doon Valley and, like its closely allied genus *Speculitermes*, is represented by a very small percentage of soldier caste. Actual records of its swarming are not available in the literature, but fully mature adults have been collected from the field in the last week of June. It may therefore be presumed that this species swarms some time during the month of July.

19. *Microcerotermes beesoni* Snyder. This species occurs in northern India in partly buried carton nests. In Doon Valley, it swarms in the second half of May. However, from other localities outside the valley, the swarming records of this species range from the last week of June to middle of July.

20. *Angulitermes dehraensis* (Gardner). This species is very common in Doon Valley and is also known from some localities in Pakistan (Layallpur and Sekesar). It occurs under stones, cowdung, outer region of mounds of genus *Odontotermes* as well as

TABLE 1
FLIGHT SCHEDULES (WITH PERIOD) OF TERMITES IN DOON VALLEY

Summer flight schedule period April-Sept.	Winter flight schedule period Oct.-March	Common flight schedule period	Elsewhere
Heterotermes indicola (July-Aug.)	Nil	*Neotermes bosei* (Feb.-Apr. & July)	*Neotermes megaoculatus megaoculatus* (May-last week)
Coptotermes heimi (June-July)		*Odontotermes assmuthi* (Feb.-Mar. & June)	*Odontotermes bhagwatii* (July-Aug.)
Stylotermes dunensis (July, 2nd half)		*O. distans* (Feb.-April &July)	
Speculitermes cyclops (May last week to June 3rd week.)			
Euhamitermes lighti (June 3rd week to July last week)			
Eremotermes dehraduni (June, 2nd half)			
Microcerotermes beesoni (May last week)			
Doonitermes capillosus (July)			
Angulitermes dehraensis (June)			
Odontotermes bhagwatii (June-Aug.)			
O. dehraduni (June-July)			
O. indicus (July-Aug.)			
O. microdentatus (June, 2nd half)			
O. obesus (June-July)			
Microtermes obesi (July)			
M. unicolar (June)			
Nasutitermes dunensis (June-July)			

under compact soil of road sides and agricultural fields near forested areas. It swarms sometimes during the 2nd half of June, when the mature sexual form is seen in small numbers (Mathur and Sen-Sarma 1959). However, precise hours of actual flights are not known.

21. *Nasutitermes dunensis* Chatterjee and Thakur. It occurs in the forest areas of Doon Valley. Actual records of swarming are not known. However, as fully mature alates have been collected in the field in the last week of May, it may be presumed that this species swarms some time during the following months of June and July, probably after showers.

DISCUSSION

The Doon Valley has a subtropical climate where temperature plays a significant role in sharply dividing the seasons, and influencing to a great extent, the flight pattern in termites. Accordingly, Doon Valley has two flight seasons, more or less linked to meteorological rhythms of rainy months, i.e. (i) *Winter flight schedule*, from October to March (sometimes extended to early April) and (ii) *Summer*

flight schedule, from April to September. This is in contrast to flight rhythms of termites at Coimbatore, south India, where there is only one flight schedule (generally from second half of September to end of March), coinciding generally with northeast monsoon. Most of the species (17) have only summer flight schedules from April to September, mostly during the monsoon months (June to August), none have solely winter flight and *Neotermes bosei* Snyder (February-April and July), *Odontotermes assmuthi* Holmgren (February-March and June) and *Odontotermes distans* Holmgren and Holmgren (February-April and July) have both summer and winter flight schedules (Table 1).

Similarly precise hours of flight schedules in 13 species, for which the data is available (Fig. 2), shows that nine species swarm generally late in the day to early in the night, two species, *Eremotermes dehraduni* Roonwal and Sen-Sarma and *Microtermes obesi* Holmgren swarm early in the day to early afternoon (1000 to 1530 hrs), two species, *Heterotermes indicola* (Wasmann) and *Odontotermes microdentatus* Roonwal and Sen-Sarma swarm at night (2100-2400 hrs and 2300 hrs respectively). In the case of *Odontotermes indicus* and *Odontotermes obesus*, the swarming sometimes continues till late in the night (upto 2300 hrs) or even throughout the night.

The time schedules of swarming in termites at any one locality are, by and large, precise, and are repeated year after year (Nutting 1969, Thakur and Sen-Sarma 1981 and Thakur 1985), but sometimes there is a departure from the normal schedules and a species may behave differently. For example, *Odontotermes assmuthi* Holmgren usually swarms at 1630 hrs during bright sunshine, but occasionally, it may also swarm in the morning (0700-0830 hrs) and even when it is cloudy or drizzling. However, such exceptions are few and rare. Similarly, some species (e.g. *Odontotermes distans*) exhibit striking time fixity. On two occasions, this species was found to swarm from two different colonies situated nearly 3 km apart on 26 February 1970 and 26 February 1973 in Dehradun. However, the hours of flight schedule were not synchronized, whereas the first swarm on 26 February 1970 occurred in the evening at sunset, the second swarm occurred on 26 February 1973 in the afternoon at 1630 hrs.

From the information available in literature, it appears that flight schedules in some species are closely linked to latitudinal and regional elevation differences over their entire range of distribution (Nutting 1969, Thakur 1985). For example, *Coptotermes heimi* has been reported to swarm from March to May in the warmer and more humid areas of Bombay, Orissa and West Bengal (approx. 19-22° N.), during monsoon months, from June to August, in the drier parts of Haryana, Punjab, Rajasthan and Uttar Pradesh (approx. 26° 5'-31° N) and further down at Coimbatore, South India (approx. 11° N) from January to February. Similarly *Odontotermes obesus* swarms during the early part of hot summer from late April (28th) to May in the western temperate climate of Himalaya (Himachal Pradesh and Western Himalaya of Garhwal, Kumaon Hills and Doon Valley in Uttar Pradesh), from June to August in the Gangetic plains in Uttar Pradesh and from October to November at Coimbatore (South India).

All these establish a positive correlation between the swarming and rainfall, but what exactly triggers swarming, is a complex problem and is only speculative at present. Many physical changes in the weather conditions in a locality, such as air pressure and humidity, moisture content in the soil and other climatic conditions, are invariably associated with the phenomenon of swarming. Any single factor or combination of factors influences the microclimatic condition in the nest, which, together with the vibration produced by the rain drops, perhaps act as stimuli for swarming. Changing conditions rather than any fixed set of absolute values provide the major climatic stimulus for flight schedules (Nutting 1969, Thakur 1985). Since observations on the swarming of termites in nature are chance records, it is not surprising that information on the precise hours of flight have so far been collected in case of 12 species only. More information is required on the swarming behaviour of more termites, particularly in the case of those species where it is lacking, from different climatic conditions at various latitudinal localities.

References

Aggarwal, V.B. (1975): Studies on the biology and ecology of mound building termites, *Odontotermes microdentatus*

Roonwal & Sen-Sarma and *Odontotermes obesus* (Rambur) (Insecta: Isoptera: Termitidae). Ph.D. Thesis, Meerut University. vii + 1-222 pp.

ARORA, G.L. & GILOTRA, S.K. (1960): The biology of *Odontotermes obesus*. *Punjab Univ. Res. Bull. 10 (3-4):* 247-255.

ASSMUTH, J. (1913): Wood-destroying white ants of the Bombay Presidency. *J. Bombay nat. Hist. Soc. 22 (2):* 372-384.

MATHUR, R.N. & SEN-SARMA, P.K. (1959): Notes on the habits and biology of Dehra Dun termites. Part I. *J. Timber Dryer's Preserv. Assoc. India,* Dehra Dun, *5(3):* 33-39.

MATHUR, R.N. & SEN-SARMA, P.K. (1960): Notes on the habits and biology of Dehra Dun termites. Part-II. *J. Timber Dryer's Preserv. Assoc. India*, Dehra Dun, *6(2):* 23-27.

MATHUR, R.N. & SEN-SARMA, P.K. (1962): Notes on the habits and biology of Dehra Dun termites. Part-III.-*J. Timber Dryer's Preserv. Assoc. India*, Dehra Dun, *8(1):* 1-18.

NUTTING, W.F. (1969): Flight and colony foundation. *In:* Biology of Termites, Vol. 2: 233-282 (Eds. K. Krishna and F.M. Weesner). Academic Press, New York.

ROONWAL, M.L. (1970): Termites of the Oriental Region - *In:* Biology of Termites, Vol. 2: 315-391 (Eds. K. Krishna and F.M. Weesner). Academic Press, New York.

ROONWAL, M.L. (1976): Field ecology and ecobiogeography of Rajasthan termites: A study in desert environment. *Zool. Johrb. Abt. (Syst.) 103:* 455-504.

ROONWAL, M.L. (1983): The ecology of termites swarming in the Indian Desert. *In:* Insect Interrelations in Forest and Agro Ecosystem; 9-13. Eds. P.K. Sen-Sarma, S.K. Kulshrestha and S.K. Sangal. Jugal Kishore and Co., Dehra Dun.

ROONWAL, M.L. & SEN-SARMA, P.K. (1955): Biology and ecology of Oriental termites (Isoptera) 3. Some observations on *Neotermes gardneri* (Snyder) (family Kalotermitidae). *J. Bombay nat. Hist. Soc. 53(2):* 234-239.

ROONWAL, M.L., SEN-SARMA, P.K. & VERMA, S.C. (1977): Resurvey of termite fauna of Rajasthan and its Zoogeography. *Rec. Zool. Surv.* 72: 125-480.

SEN-SARMA, P.K. (1962): Some observations on swarming in nature and colony foundation under laboratory conditions in *Odontotermes assmuthi* (Holmgren) at Dehra Dun. *Beitr. Zur. Entomon., 12:* 192-297.

SEN-SARMA, P.K., THAKUR, M.L., MISHRA, S.C. & GUPTA, B.K. (1975): Studies on wood destroying termites in relation to natural termites resistance of wood. Final Tech. P.L. 480 Project A-7-58 (1968-73) Dehradun. pp. viii + 1-187.

THAKUR, M.L. (1978): New observations on the swarming behaviour in nature in *Odontotermes assmuthi* Holmgren (Isoptera: Termitidae: Macrotermitinae). *Indian Forester, 104(9): 638.*

THAKUR, M.L. (1985): Observations on swarming in nature of termites (Insecta: Isoptera) at Coimbatore, Tamil Nadu. *Annls. Ent.*, Dehradun, *3(2):* 25-32.

THAKUR, M.L. & SEN-SARMA, P.K. (1981): Flight and colony foundation in termites with special reference to Indian region. *Van Vigyan, 19 (1):* 39-43.

THE STATUS OF FOUR-HORNED ANTELOPE *TETRACERUS QUADRICORNIS*[1]

Clifford G. Rice [2]

Introduction

The four-horned antelope (FHA) *Tetracerus quadricornis* is a diminutive antelope, standing 65 cm at the shoulder (Prater 1980). Despite the unusual trait of having two pairs of horns, it has attracted little scientific attention. There have been no investigations focusing specifically on this species, and it is generally given only brief treatment in accounts of multi-species studies (Schaller 1967, Krishnan 1975, Sharatchandra and Gadgil 1975). Berwick's (1974) study in the Gir Forest is a notable exception. He provides information on FHA densities, group size and composition, reproduction, habitat preference, and food habits. In order to assess the current status of this unique Indian antelope, a mail survey was carried out in 1986-87 with the following results.

Methods

Questionnaires on the status of four-horned antelope were sent to 106 wildlife administrators and 33 non-governmental organizations or private individuals in 10 states (Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh). The questionnaire requested the following information:

1. Name and location of site.
2. Area of site in sq. km.
3. Major habitat or forest types of the site.
4. Presence of FHA (yes or no).
5. Estimate of abundance of FHA based on the following definitions: **Abundant:** there are frequent sightings of FHA during an average day in the site. **Common:** 1 or 2 FHA seen during an average day in the site. **Rare:** FHA seen infrequently in the site. **Possible:** FHA have been reported in the site, but presence not yet confirmed by reliable sources. **Extinct:** reliable reports of FHA in the site in the past, but no recent evidence has been found (locally extinct).
6. Local population trend (increasing, stable, or decreasing).
7. Total population size.
8. Method by which the population size was estimated.

Information from questionnaire responses was supplemented with material from published sources (Krishnan 1975, Maheshwari 1972, Rashid 1982, Saharia 1982, Schaller 1967, Sharatchandra and Gadgil 1975, Spillett 1968a, b, c, Variava and Singh 1985) and the protected areas database of the Indian Institute of Public Administration (Kothari pers. comm.)

Results

A total of 83 sites with FHA were recorded (Appendix 1). It is likely that FHA occur in other locations, particularly on forested lands outside National Parks and Sanctuaries. However, it is likely that the geographic and ecological distributions of FHA are reasonably represented by the material obtained.

FHA populations were reported from sites in all 10 states: Andhra Pradesh-13 sites, Bihar-3, Gujarat-3, Karnataka-7, Madhya Pradesh-24, Maharashtra-13, Orissa-6, Rajasthan-5, Tamil Nadu-6, and Uttar Pradesh-4. Only two sites reported that FHA were locally extinct (the proposed Karlapat Sanctuary, Orissa and Keoladeo National Park, Rajasthan). So despite the potential for local population reductions, the overall geographic range of the FHA has apparently not been significantly reduced in the recent past.

Of the 30 sites for which habitat type information was available, 26 (87%) contained southern tropical dry deciduous (teak, *Tectona grandis*) forest (type 5A, Champion 1936), 14 (47%) contained northern tropical dry deciduous (sal, *Shorea robusta*) forest (type 5B), 14 (47%) contained south Indian moist deciduous (teak) forest (type 3B), 7 (23%) contained edaphic types of dry deciduous forests (type 5/E1, 2, 6, 9), 7 (23%) contained tropical scrub thorn forests (types 5/DS and 6), and 5 (17%) contained north Indian moist deciduous (sal)

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[1]Accepted July 1989
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TABLE 1
POPULATIONS OF FOUR-HORNED ANTELOPE REPORTED TO BE DECLINING

Site	State	Area (km^2)	Population Size
Hazaribagh Sanctuary	Bihar	183	10
Kheoni Sanctuary	M. P.	123	–
Talamalai Reserve Forest	Tamil Nadu	250	–
Mudumalai Sanctuary	Tamil Nadu	250	50
Renukoot Forest Division	U.P.	–	–
Gona Reserve Forest	U.P.	147	–
Madaura Reserve Forest	U.P.	200	–
Lalitpur Reserve Forest	U.P.	143	–

M.P. = Madhya Pradesh, U.P. = Uttar Pradesh

TABLE 2.
POPULATION OF FOUR-HORNED ANTELOPE AT OPTIMUM SITES

Site	State	Area (km^2)	Population Size	Density (km^2)
Gir National Park & Sanctuary	Gujarat	1,412	1,063	0.75
Pench Sanctuary	M.P.	118	94	0.80
Panna National Park	M.P.	543	478	0.88
Dhaknakolkaz Sanctuary	Maharashtra	382	488	1.28

Sites with reported densities greater than 0.70/ sq. km have been considered as optimum sites.

forest (type 3C). The G test (Sokal and Rohlf 1969) for interaction between habitat and reported abundance showed no significant effect (G=32.8, d.f. = 24).

Subjective assessments of FHA abundance based on the criteria provided were available for 21 sites: abundant-2 (10%), common-10 (48%), uncommon-6 (29%), rare– 2 (10%), and locally extinct-2 (10%). FHA were thought to be increasing in 6 sites (32%), stable in 5 (26%), and decreasing in 8 (42%, N =19). Reasons for an increasing population are of interest, but particular attention should be paid to the factors responsible for population declines, something not addressed in the survey. Sites reporting declining population are listed in Table 1. It is perhaps significant that most of these sites are on the periphery of the FHA's range and are not in areas specifically dedicated to wildlife preservation.

The Gir Forest is the only site for which there have counts of FHA over a span of several years. Berwick (1974) calculated a FHA population of 256 for 1970, but thought the actual population might be as high as 800. Since then water hole counts have produced the following population estimates for Gir: 1974-977,1977-1,042; 1985-1,063 (Rashid 1982, Gujarat Wildlife Division undated).

The 4 sites with densities greater than 0.7/ sq km which may be considered optimum sites for FHA are listed in Table 2.

DISCUSSION

Despite the difficulties inherent in summarizing second-hand accounts, several conclusions may be drawn concerning the status of FHA. For most populations, little information was available beyond the presence or absence of FHA. Solid figures are needed on population sizes and trends. In addition, many aspects of the biology of this species remain unclear. Informed management of existing populations cannot proceed without further information.

With numerous widely-spread populations, there is little need for concern for the immediate survival of this species. However, many of the populations are small, the majority for which we have information being under the recommended minimum of 500 for sustaining genetic variability (Frankel and Soule 1981). However, it is not known at present how insular these populations are — that is to say how large actual interbreeding populations are. Nevertheless, it is likely that FHA populations are becoming increasingly isolated as human impacts intensify and spread. Given the low densities and small population sizes that are common for FHA, there is every bit as much justification for concern over the genetic management of these populations as there is for the populations of more spectacular species such as tigers. The FHA would, in fact, be an excellent candidate for trial efforts for techniques in genetic monitoring and conservation management.

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References

Berwick, S. (1974): The community of wild ruminants in the Gir Forest Ecosystem, India. Ph.D. Thesis. Xerox University Microfilms, Ann Arbor, Michigan, U.S.A.

Champion, H. G. (1936): A preliminary survey of the forest types of India and Burma. *Indian Forest Records 1:* 1-286.

Frankel, O.H. & Soule, M. E. (1981): Conservation and Evolution. Cambridge Univ. Press, Cambridge.

Gujarat Wildlife Division (undated): Gir Lion Sanctuary. The Deputy Conservator of Forests, Sasan-Gir.

Krishnan, M. (1975): India's Wildlife in 1959-70. Bombay Natural History Society, Bombay.

Maheshwari, J.K. (1972.): Plant wildlife and conservation in Shivpuri National Park, India. *Biol. Conserv. 4:* 214-219.

Prater, S.H. (1980): The book of Indian Animals. 3rd ed., Bombay Natural History Society, Bombay.

Rashid, M. A. (1982): The Gir Lion Sanctuary Project. pp. 138-147 *In:* V.B. Saharia (ed). Wildlife in India. Natraj Publishers, Dehra Dun.

Saharia, V. B. (1982): Wildlife in India. Natraj Publishers, Dehra Dun.

Schaller, G.B. (1967): The Deer and the Tiger. University of Chicago Press, Chicago.

Sharatchandra, H. C. & Gadgil, M. (1975): A year of Bandipur. *J. Bombay nat. Hist. Soc. 72:* 623-647.

Sokal, R.R. & Rohlf, F.J. (1969): Biometry. W.H. Freeman, San Francisco.

Spillett, J.J. (1968a): A report on wild life surveys in South and West India. *J. Bombay nat. Hist. Soc. 65:*1-46.

Spillett, J.J. (1968b): A report on wild life surveys in South and West India. *J. Bombay nat. Hist. Soc.* 65:296-325.

Spillett, J.J (1968c) A report on wild life surveys in South and West India. *J. Bombay nat. Hist. Soc. 65:* 633-663.

Variava, D. & Singh, S. (1985): Directory of National Parks and Santuaries in India. Indian Institute of Public Administration, Delhi.

Appendix 1

LOCATIONS OF REPORTED FOUR-HORNED ANTELOPE POPULATIONS IN INDIA.

Site	District (s)	State
Gona Reserve Forest	Lalitpur	Uttar Pradesh
Lalitpur Reserve Forest	Lalitpur	Uttar Pradesh
Madaura Reserve Forest	Lalitpur	Uttar Pradesh
Renukoot Forest Division	Mirzapur	Uttar Pradesh
Hazaribagh Sanctury	Hazaribagh	Bihar
Kodarma Sanctuary	–	Bihar
Palamau Tiger Reserve	–	Bihar
Kumbhalgarh Sanctuary	Udaipur	Rajasthan
Phulwari Sanctuary	–	Rajasthan
Sariska National Park & Sanctuary	Alwar	Rajasthan
Sitamata Sanctuary	Chittorhgarh & Udaipur	Rajasthan
Todgarh Raoli Sanctuary	Ajmer & Udaipur	Rajasthan
Gir National Park &Sanctuary	Junagadh	Gujarat
Purna Sanctuary	–	Gujarat
Vansda Reserve Forest	Dang	Gujarat
Bandhavgarh National Park	Shahdol & Jabalpur	Madhya Pradesh
Barnawapara Sanctuary	Raipur	Madhya Pradesh
Bori Sanctuary	Hoshangabad	Madhya Pradesh
Indravati National Park	Bastar	Madhya Pradesh
Kanger Ghati National Park	Bastar	Madhya Pradesh
Kanha National Park	Mandla & Balaghat	Madhya Pradesh
Kheoni Sanctuary	Dewas	Madhya Pradesh
Kutree Sanctuary	–	Madhya Pradesh
Madhav National Park	Shivpur	Madhya Pradesh
Mandasur Forest Division	–	Madhya Pradesh
Nauradehi Sanctuary	Damoh, Sagar &Narasinghpur	Madhya Pradesh
Pachmarhi Sanctuary	Hoshangabad	Madhya Pradesh
Palpur Kund Sanctuary	Morena	Madhya Pradesh
Panna National Park	Panna	Madhya Pradesh
Panpatha Sanctuary	Shahdol	Madhya Pradesh
Pench National Park	Seoni & Chhindwara	M.adhya Pradesh
Pench Sanctuary	Seoni	Madhya Pradesh

APPENDIX 1 (Contd.)

Site	District (s)	State
Ratadani Sanctuary	Raisen	Madhya Pradesh
Sanjay Sanctuary	Sidhi	Madhya Pradesh
Satpura National Park	Hoshangabad	Madhya Pradesh
Seoni Forest Division	Seoni	Madhya Pradesh
Shivpuri National Park	–	Madhya Pradesh
Singhori Sanctuary	Raisen	Madhya Pradesh
Tadoba National Park	–	Madhya Pradesh
Udanti Sanctuary	Raipur	Madhya Pradesh
Bamragarh Forest Division	–	Maharashtra
Dhaknakolkaz Sanctuary	Amravati	Maharashtra
Karnala Sanctuary	Raigad	Maharashtra
Melghat Sanctuary	Amravati	Maharashtra
Nagzira Sanctuary	Bhandara	Maharashtra
Nawegaon National Park	Bhandara	Maharashtra
Osmanabad Forest Division	–	Maharashtra
Pench National Park	Nagpur	Maharashtra
Sanjay Gandhi National Park	Thane &Bombay	Maharashtra
South Chanda Forest Division	–	Maharashtra
Tansa Sanctuary	Thane	Maharashtra
West Nasik Forest Division	–	Maharashtra
Badrama Sanctuary	–	Orissa
Chandaka Dampada Sanctuary	Puri &Cuttack	Orissa
Kotagarh Sanctuary	–	Orissa
Satkosia Sanctuary	Dhenkanal &Cuttack	Orissa
Simlipal National Park & Sanctuary	Mayurbhanj	Orissa
Eturnagaram Sanctuary	–	Andhra Pradesh
Giddalur Forest Division	–	Andhra Pradesh
Gudem Sanctuary (proposed)	–	Andhra Pradesh
Karimnagar Reserve Forest	–	Andhra Pradesh
Kawal Sanctuary	Adilabad	Andhra Pradesh
Kinnersani Sanctuary	Khamman	Andhra Pradesh
Lankamallai Sanctuary	–	Andhra Pradesh
Nagarjunsagar-Srisailam Sanctuary	Mahboobnagar	Andhra Pradesh
Pakhal Sanctuary	Narangal	Andhra Pradesh
Papikonda Sanctuary	E. & W. Godavari	Andhra Pradesh
Pranhita Sanctuary	Adilabad	Andhra Pradesh
Siwaram Sanctuary	Adilabad & Karimnagar	Andhra Pradesh
Venkateshwara Sanctuary	–	Andhra Pradesh
Bandipur National Park	Mysore	Karnataka
Dandeli Sanctuary	–	Karnataka
Mookambika Sanctuary	Dakshina Kannada	Karnataka
Nagarhole National Park	Mysore &Coorg	Karnataka
Sharavathi Sanctuary	Shimoga	Karnataka
Shettihalli Sanctuary	–	Karnataka
Tungabhadra Sanctuary	Bellary	Karnataka
Mudumalai Sanctuary	Nilgiris & Mudumalai	Tamil Nadu
Sigur Range	Nilgiris	Tamil Nadu
Talamalai Reserve Forest	Periyar	Tamil Nadu

TAXONOMIC COMPOSITION AND DISTRIBUTION OF *BRACHIONUS* (ROTATORIA: MONOGONONTA) POPULATIONS IN PONDS[1]

R. SAMPATHKUMAR[2]

(*With twelve text-figures*)

The different species and varieties constituting the *Brachionus* population of four freshwater fish-ponds at Tuticorin, south India, were identified and their numerical abundance and frequency of occurrence studied over a period of 19 weeks. Nine varieties belonging to seven species of *Brachionus* were identified. The identified taxa were compared and contrasted with those reported from other parts of India. *B. calyciflorus* var. *anuaeriformis*, *B. plicatilis* and *B. angularis* var. *angularis* dominated the populations during most of the investigation period. The other species and varieties occurred occasionally or rarely.

INTRODUCTION

Rotifers in general, and *Brachionus* in particular, form an important constituent of zooplankton biomass of freshwater fish ponds. Their importance as food or in the food chain of fish is often emphasised (Jyoti and Sehgal 1979).

However, studies on this group in fish ponds are limited, although several works have been carried out in natural waters of the northern part of India (George 1961, Jyoti and Sehgal 1979, Nasar 1973, Pasha 1961, Sharma 1976, 1979, 1980, 1981, 1983) and some in the southern part of India (Dhanapathi 1974, Naidu 1967, Nayar and Nair 1969, Pasha 1961). Such studies in south Tamil Nadu are almost absent. In the present study the species and varietal composition of the genus *Brachionus* of fish ponds and their weekly distribution are dealt with.

MATERIAL AND METHODS

Four freshwater fish culture ponds located in the premises of Fisheries College, Tuticorin (Tamil Nadu) were selected for the present study. The man-made earthern ponds were under semi-intensive carp culture. Weekly plankton samples were collected using a plankton net of 60 µm mesh size over a period of 19 weeks from 8 November 1986 to 13 March 1987. The samples were preserved in 5% formalin prior to microscopic identification, measurement and enumeration.

RESULTS AND DISCUSSION

During the study, a total of ten taxa (nine varieties belonging to seven species) were identified from the four ponds. The species are discussed in order of decreasing abundance. Table 1 gives the measurements of the taxa. The weekly variations in the numerical abundances of the taxa are presented in Fig. 12.

1. Brachionus calyciflorus

This species was represented by three varieties. Sharma (1979), however, preferred to place the three as 'formae' and refrained from calling them 'varieties'.

(i) *B. calyciflorus* v. *anuaeriformis* Brehm, 1909: Antero-dorsal (occipital) margin of lorica with four long and equal spines. Postero-lateral spines long, slender and diverging. Two caudal spines shorter (Fig. 1). The form is identical with that reported from Punjab (Vasisht and Battish 1971).

This variety was one of the two taxa occurring throughout the period of study except in the sample of 8 November 1986. Swarming of the variety was noticed whenever the dissolved oxygen in water was high (above 5.0 ppm).

(ii) *B. calyciflorus* v. *dorcas* Gosse, 1851: Lorica rounded and highly stippled. Occipital margin with four spines of which medians twice as long. Base of medians wide (Fig. 2).

This variety occurred less frequently and less abundantly than *B. calyciflorus anuaeriformis*.

(iii) *B. calyciflorus* v. *hymani* Dhanapathi, 1974: Occipital margin of the lorica with four wide-

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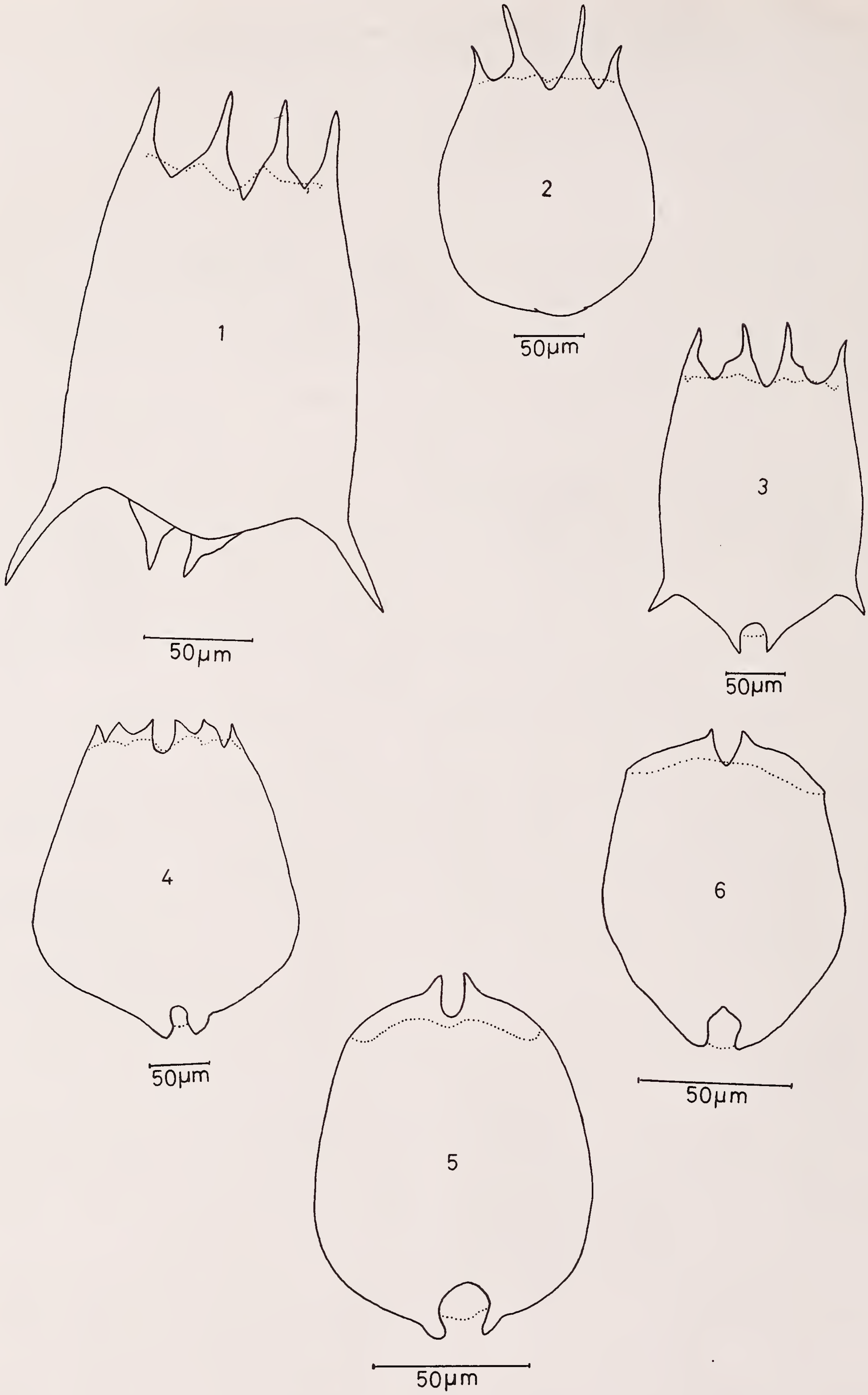


Figs. 1-6. *Brachionus* spp.
1. *Brachionus calyciflorus* v. *anuaeriformis*, 2. *B. calyciflorus* v. *dorcas*; 3. *B. calyciflorus* v. *hymani*, 4. *B. plicatilis*, 5. *B. angularis* v. *angularis*, 6. *B. angularis* v. *bidens*.

based spines of which the laterals slightly shorter. Outer base of the medians bearing a tooth-like projection. Antero-ventral spines flanking the median sinus and less prominent in contrast to the form reported from West Bengal (Sharma 1979) (Fig. 3). Sharma. (1979) identified this taxon as *B. calyciflorus* f. *borgeti*.

This variety occurred rarely.

2. **Brachionus plicatilis** Muller, 1786:

Posterior of lorica broad. Occipital spines six which are short, stumpy and broad- based. Separations between medians and intermediates less distinct. Median sinus very deep and U-shaped. Antero-ventral margin wavy. Foot opening deep and flanked by tooth-like projections (Fig. 4).

This species also occurred throughout the study period (except in the sample of 19 December 1986) as *B. calyciflorus anuaeriformis*. Also, this species was the most abundant of all taxa. Swarming of the species was noticed at ponds at times of low dissolved oxygen.

3. **Brachionus angularis**

(i) *B. angularis* v. *angularis* Gosse, 1851: Anterior margin of the lorica characteristically rounded and slightly narrower than the posterior. Occipital spines two, short, slightly pointed and flanking the deep U-shaped median sinus. Antero-ventral margin more or less parallel to the dorsal margin, showing a shallow depression at median and curved anteriorly at corners. Foot opening flanked by two short and rounded caudal spines bent inwards (Fig. 5).

The frequency of occurrence and abundance of this variety was high, being next to that of *B. calyciflorus anuaeriformis* and *B. plicatilis*. In most instances it co-occurred with *B. plicatilis* except during mid-December to mid-March when this variety showed a rare occurrence.

(ii) *Brachionus angularis* v.*bidens* Plate, 1886: Occipital margins of the lorica flattened. This variety differs from *B. angularis angularis* in having smaller median spines, V-shaped sinus and ventral margin being more parallel to the dorsal margin and not wavy. Caudal end of lorica somewhat tapering (Fig. 6).

This variety occurred less frequently and less abundantly than *B. angularis angularis*.

4. **Brachionus urceolaris** v. **urwaensis** Sudzuki, 1964

Lorica broad and bulged at middle. Dorsal and ventral plates separated. Occipital spines six. Medians slender, pointed and flanking the deep median sinus. Laterals also slender but slightly shorter and less pointed than other spines. Intermediates very broad with pointed ends. Caudal opening wide and flanked by two spine-like projections (Fig. 7).

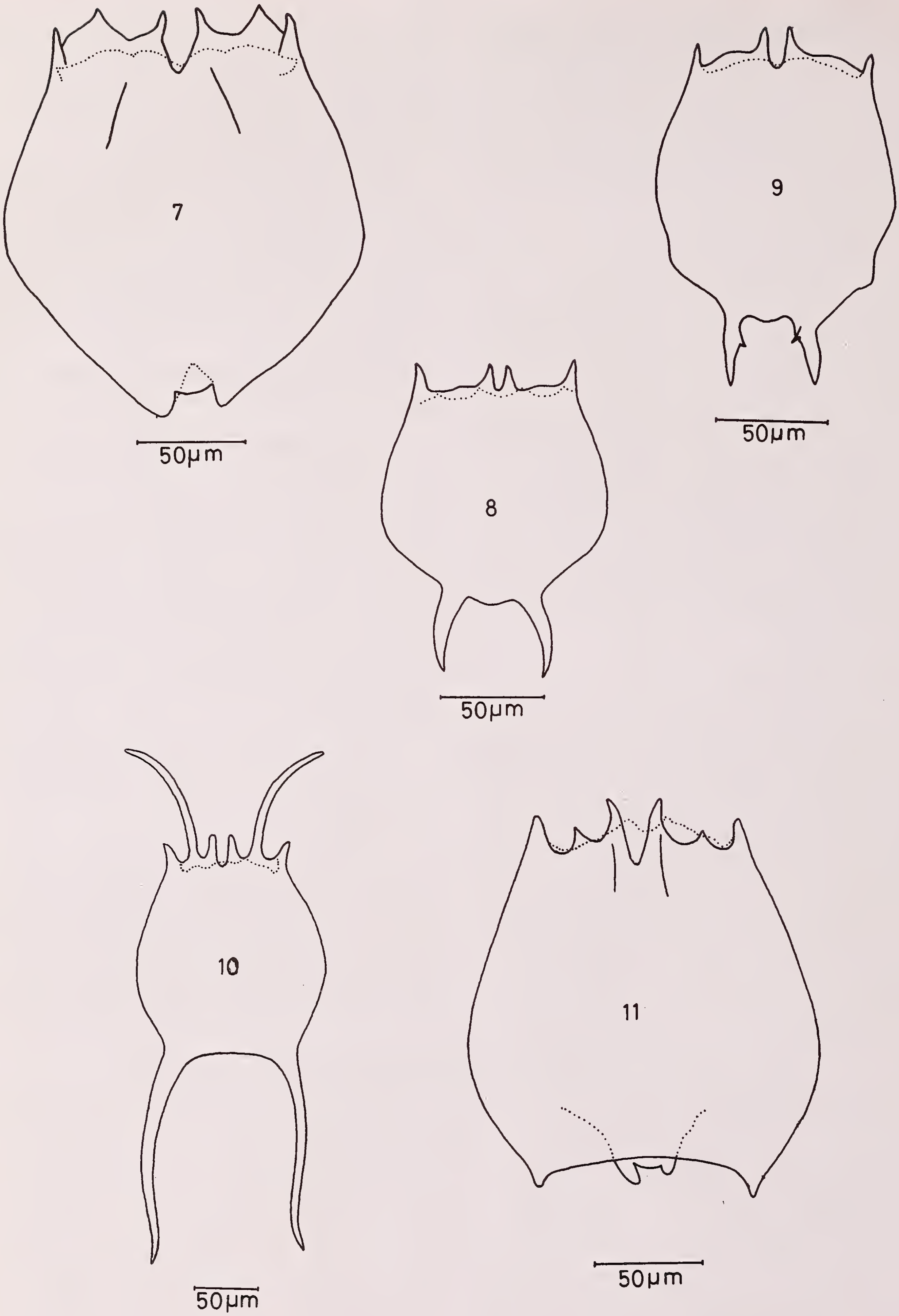
This species was rare during the study.

5. **Brachionus caudatus** v. **aculeatus** Hauer 1937

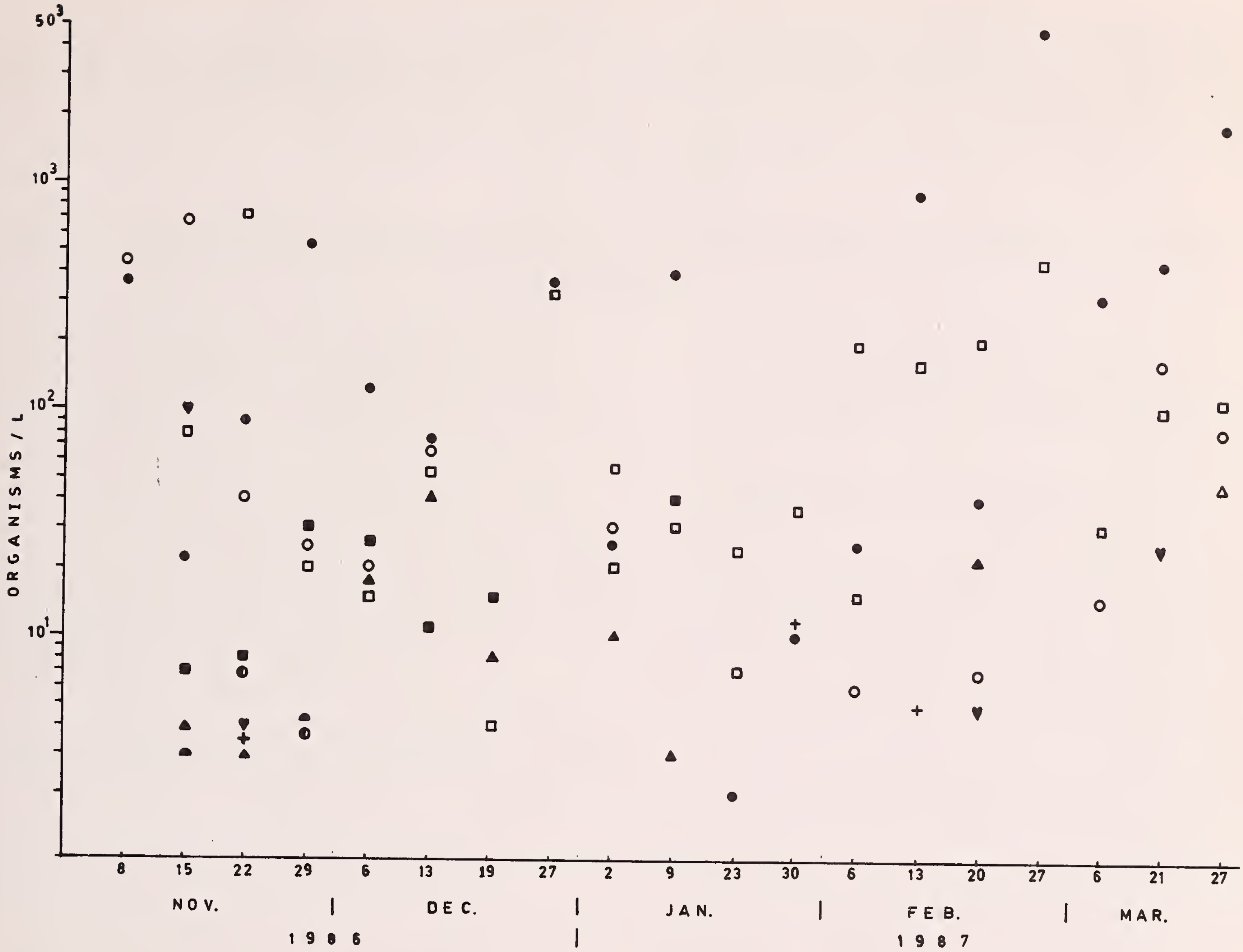
Occipital margin somewhat flat with two medians and two laterals, all short and pointed at ends. Intermediates absent. Two long caudal spines with blunt ends and curved inwards (Fig. 8). This form was identical with that reported from Andhra Pradesh (Dhanapathi 1974). Another form identical

TABLE 1
MEASUREMENTS OF TAXA OF *Brachionus* FROM FISH PONDS AT TUTICORIN

Taxon of *Brachionus*	Total length (µm)	Maximum width (µm)
B. calyciflorus anuaeriformis	243	138
B. calyciflorus hymani	280	170
B. calyciflorus dorcas	217	152
B. angularis angularis	117	88
B. angularis bidens	105	80
B. plicatilis	260	220
B. urceolaris urwaensis	184	164
B. caudatus aculeatus (Fig. 8)	136	101
B. caudatus aculeatus (Fig. 9)	162	104
B. falcatus lyratus	450	170
B. quadridentatus rhenanus	180	160



Figs. 7-11. *Brachionus* spp.
7. *B. urceolaris* v. *urwaensis*, 8. & 9. *B. caudatus* v. *aculeatus*, 10. *B. falcatus* v. *lyratus*, 11. *B. quadridentatus* v. *rhenanus*.



Brachionus calyciflorus v. *anuaeriformis*.
B. plicatilis.
B. urceolaris v. *urwaensis*.
B. quadridentatus v. *rhenanus*.
B. calyciflorus v. dorcas.
B. angularis v. *angularis*.
B. caudatus v. *aculeatus*.
B. calyciflorus v. *hymani*.
B. angularis v. *bidens*.
B. falcatus v. *lyratus*.

Fig. 12. Weekly variations in the numerical abundance of taxa of *Brachionus* (The values are averages of the four ponds)

with the one reported from Orissa (Sharma 1980) was also found to occur. The latter had straight posterior spines with a sharp hook-like projection at the base, a bulge at the middle and pointed ends (Fig. 9).

Both the forms of this variety occurred only twice in the study (15 and 21 November 1986).

6. Brachionus falcatus v. lyratus
Lemmerman, 1908

Lorica with six occipital spines, all blunt. Medians straight and marginally longer than the laterals. Laterals slightly curved and pointed outwards. Intermediates seven times as long as the medians and bent outwards. Two posteriors extremely long, curved inwards but ends bent outwards. Except the relatively greater curvature of the intermediates, the form is identical with the one reported from Bihar (Nasar 1973) (Fig. 10).

This species was found to occur only twice during the study (22 and 29 November 1986).

7. Brachionus quadridentatus v. rhenanus
Lauterborn 1893

Posterior half of lorica laterally bulged. Occipital spines six. Medians flanking deep V-shaped median sinus and bent gently outwards. Intermediates less distinct, short, broad and pointed. Laterals longer than intermediates and shorter than medians. Antero-ventral margin with two spine-like

median projections flanking a shallow sinus. Posterior margin slightly flattened bearing two short nipple-like spines at ends (Fig. 11). This form was identical with the one reported from Punjab (Sharma 1981).

This taxon of *Brachionus* occurred only once during the study (21 March 1987).

Acknowledgements

I thank Dr N. Sukumaran, Fisheries College, Tuticorin, for correcting the manuscript critically.

References

Dhanapathi, M.V.S. (1974): Rotifers from Andhra Pradesh, India — I. *Hydrobiologia 45 (4):* 357-372.

George, M.G. (1961): Observations on the rotifers from shallow ponds in Delhi. *Curr. Sci. 30:* 247-250.

Jyoti, M.K. & Sehgal, H. (1979): Ecology of Rotifers of Surinsar, a subtropical freshwater lake in Jammu (J & K), India. *Hydrobiologia 65:* 23-32.

Michael, R.G. (1973): A Guide to the study of freshwater organisms: Rotatoria. *J. Madurai Univ. Suppl. 1:* 23-36.

Naidu, K.V. (1967): A contribution to the Rotatorian fauna of South India/. *J. Bombay nat. Hist. Soc. 64:* 384-388.

Nayar, C.K.G. & Nair, K.K.N. (1969): A collection of Brachionid rotifers from Kerala. *Proc. Indian Acad. Sci. 69:* 223-233.

Nasar, S.A.K. (1973): The zooplankton fauna of Bhagalpur: Rotifera. *J. Bhagalpur Univ. 6 (1):* 55-62.

Pasha, S.M.K. (1961): On a collection of freshwater rotifera from Madras. *J. Zool. Soc. India 13 (1):* 50-55.

Sharma, B.K. (1976): Rotifers collected from North-West India. *Newsl. Zool. Surv. India 2 (6):* 255-258.

Sharma, B.K. (1979): Rotifers from West Bengal. 3. Further studies on the Eurotatoria. *Hydrobiologia 64 (3):* 239-250.

Sharma, B.K. (1980): Contributions to the rotifer fauna of Orissa, India. ibid. *70:* 225-233.

Sharma, B.K. (1981): Contributions to the ratifer fauna of Punjab State, India. I. Family Brachionidae. ibid. *76:* 249-253.

Sharma, B.K. (1983): The Indian species of the genus *Brachionus* (Eurotatoria: Monogononta: Brachionidae). ibid. *104:* 31-39.

Vasisht, H.S. & Battish, S.K. (1971): The rotifer fauna of North India: *Brachionus. Res. Bull. (n.s.) Punjab Univ. 22* (1/2): 179-188.

A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY—34: MUSCICAPIDAE (TURDINAE)

HUMAYUN ABDULALI AND SARASWATHY UNNITHAN

[Continued from *Vol. 85(1)*: 134]

This part covers some 497 specimens of 40 species and subspecies up to No. 1768 in HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN and 4 extra limitals. Of the 40 from Indian limits we have no specimens of 6, species (3) and subspecies (3). HA was not able to attend work for a considerable period (due to ill-health) and most of the work has been completed by Dr (Mrs) Saraswathy Unnithan.

1731 **Zoothera wardii** (Blyth) (Mysore) Pied Ground Thrush 2:145

5: 3 males 2 females

1 Simla, 1 Garhwal; 3 Pt. Calimere, Tanjore dist., Tamil Nadu.

One male obtained at Simla in May and a female at Point Calimere in October have yellow bills. The former appears to be breeding(?) being paler above than the other, dating back to June 1871.

Measurements on p. 77.

1732 **Zoothera sibirica sibirica** (Pallas) S.E. Transbaicalia Whitebrowed Ground Thrush 2:146

nil

1732a **Zoothera sibirica davisoni** (Hume) (Muleyit) Davisons Ground Thrush

4: 2 males 1 female 1 (?)

1 Mahableshwar, W. Ghats; 1 Narcondam Is.; 2 *Kobe, Japan.*

The female (?) from Mahableshwar (7 April 1969) is slightly larger than nominate *sibirica* (Footnote to p. 85, Vol. 9, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN 1973) for it has a 122/3 wing but being in female plumage is slightly smaller than the males.

Measurements on p. 77.

1733 **Zoothera citrina citrina** (Latham) (India, Cachar) Orange-headed Ground Thrush 2:148

19: 10 males 6 females 3 (?)

2 Gama-ki-hatti, Dharmi State, 1 Bhajji State, N.W.H.; 1 Ratnagiri, 1 Kumaon; 1 Sardar River, Pilibhit dt., 1 Salukapur Forest, Kheri dt., U.P.; 1 Tribeni, 1 Chalnakhel, 1 Bankulwa, Morang, Nepal; 1 Madhubani, Darjeeling, 2 Baghowni, Tirhut dt., 1 Sarun, Bengal; 1 Margherita, Assam; 1 Keonjhargarh, 1 Kuldiha, Nilgiri, Orissa, 1 Kalavaghu, Sriharikotta, 1 *Nyaunggyo, Prome* dt., *Burma.*

Measurements on p. 77.

1734 **Zoothera citrina cyanotus** (Jardine & Selby) (Bangalore, India) Whitethroated Ground Thrush 2:150

25: 14 males 9 females 2 (?)

1 Sonagadh, Navsari dt., Gujerat; 1 Goregaon, 1 Kallian, 1 Khandala, 2 Mahableshwar, 1 Koyna, Maharashtra; 1 Goa frontier, 1 Molem, 1 Valpoi, Goa; 1 Kaithali, Karwar, 3 Karwar, 1 North Kanara; 1 Murgimatta, Sagar, 1 Ulavi, Shimoga, 1 Honnametti, Attikan Estate, Mysore; 1 Cheranbadi, Gudalur, Nilgiri; 3 Perumalmalai Coffee Estate, 1 Manalur, Palni Hills; 1 Santanpara, Cardamom Hills; 1 Tenmalai, C. Travancore.

In *amadoni* (Abdulali, 1965, *JBNHS* 62: 305–6) the differences do not appear clinal as suggested by Ripley (1973, IH 9, footnote p. 89). The small differences for which they have been separated, would prevent a revision and it may perhaps be best to leave this as a synonym of *cyanotus*, and leave it to somebody with more material (say at the British Museum) to attempt the necessary changes.

They are however separately measured under 1734 (a).

1734a **Zoothera citrina amadoni** Biswas (Chanda, C.P.)

20: 11 males 7 females 2 (?)

1 Parijat, 2 Jabalpore; 2 Bhanupratappur, Kanker, C.P.; 1 Bhopalpatnam; 1 Dantewara, 1 Golapalli, Bastar dt.; 1 Chahala, Simlipal Hills, 1 Pithabrata, Mayurbhanj, 4 Badrama, Bamra, 1 Tikerpara, Angul dt., Orissa; 1 Jeypore Agency, 1 Bhadrachalam, 1 Dharakanda, Upper Sileru, 1 Sankrametta, 1 Anantgiri, Vizagapatnam.

Measurements on p. 77.

1735 **Zoothera citrina andamanensis** (Walden) (Andamans) Andaman Ground Thrush 2:152

6: 5 males 1 female

1 Thugapur, Maya Bunder, 2 Landfall Is., 1 South Cinque Is.; 1 Bakultala, M. Andaman; 1 Chiria Tapoo, S. Andaman.

The underparts are darker than in *Cyanotus* and also slightly smaller.

Measurements on p. 77.

1736 **Zoothera citrina albogularis** (Blyth) (Nicobar Islands) Nicobar Ground Thrush 2: 153

5: 3 males 2 females

1 Car Nicobar; 3 Nancowry, 1 Camorta, Middle Nicobars.

The throat is a little whiter and the underparts darker (more chestnut) than in *andamanensis* and also smaller than in *cyanotus*.

Measurements on p. 77

1737 **Zoothera spiloptera** (Blyth) Spottedwinged Ground Thrush 2:165

nil

1738 **Zoothera mollissima whiteheadi** (Baker) (Khagan Valley, Afridi Country, N.W.F.P.) Western Plainbacked Mountain Thrush 2:163

7: 2 males 5 females

5 Simla, 2 Pilibhit Terai, U.P.

simlaensis (Baker) from Simla appear to be synonymous with *whiteheadi*.

Measurements on p. 77.

1739 **Zoothera mollissima mollissima** (Blyth) (Darjeeling) Eastern Plainbacked Mountain Thrush 2:162

9: 6 males 3 females

1 Temi, West Sikkim, 1 Chungthang, N. Sikkim; 1 Batase, Central Bhutan; 4 Gomchu, 1 Wamrong, 1 Rongtong, East Bhutan.

Measurements on p. 77.

1740 **Zoothera dixoni** (Seebohm) (Himalayas, near Nepal and Darjeeling) Longtailed Mountain Thrush 2:162

11: 5 males 1 female 5 (?)

1 Nila Valley, 2 Garhwal; 1 Chengthang, N. Sikkim; 1 Temi, West Sikkim; 1 Batase, Central Bhutan; 1 Gomchu, 1 Narphong; 1 Wamrong, E. Bhutan; 1 *Loi Long*, 1 *Yangh, North Shan State*.

These are similar to *Z. mollissima mollissima* in their darker upperparts, but the two bars on the wing, the pale shaft streaks on the forehead, the greater amount of white on the lower underparts and the longer tail (95–111, av. 99.2) separate them and there is no room for confusion.

Measurements on p. 77.

1741 **Zoothera dauma dauma** (Latham) (Kashmir) Smallbilled Mountain Thrush 2:153

26: 12 males 11 females (1 juvenile) 3 (?)

1 Chitral; 5 Simla, 1 Jagadri, Ambala; 2 Bankuwa, Morang, Nepal; 1 Rinchingpong, 2 Temi, W. Sikkim; 2 Gedu, W. Bhutan, 1 Mangdechu, 1 Shamgong, C. Bhutan, 1 Rongtong, E. Bhutan, 1 Tougloo, Bhutan (juvenile); 1 Khasia Hills, 1 Margherita, Assam; 1 Singtam, Teesta Valley, 1 Sarun, Bengal; 1 Gurguria, Simlipal Hills, 1 Ranipathar, Phulbani dt., Orissa; 1 *Nyaunggyo, Burma*, 1 *Upper Burma*.

These birds fall into two distinct groups, one darker and the other paler, but it is not possible to isolate them by locality or any other data.

Measurements on p. 77-78.

1742 **Zoothera dauma neilgherriensis** (Blyth) (Neilgherries) Nilgiri Thrush 2: 159

3: 1 female 2 (?)

1 Ooty, 1 Chimugi, 1 Honnematty Estate, Mysore.

Measurements on p. 78.

1743 **Zoothera dauma imbricata** Layard (Ceylon) Ceylon Scaly Thrush 2:160

nil.

1744 **Zoothera dauma aurea** (Holandre) (Metz, France) Golden Thrush 2:161

2: 1 female 1 (?)

1 Tirap div., Arunachal Pradesh; 1 *Thandaug, Toungoo dist., Burma* (J.H.D. Mackenzie).

The bird obtained in Arunachal Pradesh on 14 Dec. 1981 shows much darker than white above. The female from Thundaug, Toungoo dist., Burma, (no date) agrees with the paler birds of *dauma dauma*. Both have 14 rectrices in the tail which apparently make it this subspecies.

Measurements on p. 78.

1745 **Zoothera monticola monticola** Vigors (Simla–Almora area) Large Brown Thrush 2:166

12: 5 males 2 females 5 (?).

1 Koti State, 1 Bhajji State, 5 Simla, N.W.H.; 1 Bhim Tal, Kumaon, 1 Garhwal, 1 Almora, 1 Naini Tal; 1 Gedu, W. Bhutan.

There is some variation in the depth of brown of the upperparts but this does not appear to coincide with any dates or sexes.

Measurements on p. 78.

1746 **Zoothera marginata** Blyth (Arracan) Lesser Brown Thrush 2: 168

5: 2 males 2 females 1 (?)

1 Bhutan Duars; 3 Margherita, Assam; 1 *Mt. Victoria, Pakoku Hill Tracts, Burma*.

Measurements on p. 78.

1747 **Turdus dissimilis dissimilis** Blyth (Lower Bengal) Black-breasted Thrush 2:140

4 males

1 Firm Base, 1 Namdrik, 2 Arunachal Pradesh

The measurements appear smaller than IH/9 p. 120.

Measurements on p. 78.

1748 **Turdus unicolor** Tickell (Borabhum, Purulia dt., W. Bengal) Tickell's Thrush 2:136

29: 14 males 12 females 3 (?)

1 Quetta, Pishim dt., Baluchistan; 2 Chitral, 2 Srinagar, 1 Mogul Maidan, 2 Kashmir; 1 Dunga Gali, Muree Hills; 2 Simla Hills, 4 Simla; 2 Basantpur, Bhahh State; 1 Almora, 4 Pilibhit Terai; 1 Karwapani, Sivaliks, U.P.; 1 Trikein, Hathiban, Nepal; 1 Karwapani, Sivaliks, U.P.; 1 Trikein, Hathiban, Nepal; 1 Pithabata, Myurbhanj, 1 Kuldiha, Nilgiri, 1 Orissa; 1 Berar, C.P.; 1 Anantgiri, Vizagapatnam.

16671 male Simla, and 16670 male Simla appeared to be *unicolor* but all lacked rufous on under wing coverts and were sent to B.M. and got confirmed).

Measurements on p. 78.

1749 **Turdus albocinctus** Royle (Himalayas, restricted to Dehra Dun) Whitecollared Blackbird

21: 13 males 7 females 1 (chick)

1 *Gacha, Tsangpo, S. Tibet*; 1 Kufri, Patiala, 6 Simla; 1 Shivpuri, Kathmandu Valley, Nepal; 1 Mountains, n.w. of Mussoorie, 2 Dakuri, 2 Garhwal, U.P., 2 Shamgong, Central Bhutan; 1 Tongloo, 1 Darjeeling, Bengal; 1 Deoban Jaunsar 9000, 2 no data.

Measurements on p. 78.

1750 **Turdus boulboul** (Latham) (India = Darjeeling) Greywinged Blackbird 2:130

43: 25 males 17 females 1 (?)

1 Dunga Gali, 1 Muree, N.W.F.P.; 1 Golhar, Kishtwar, 12 Simla, 1 Koti State, Simla Hills; 2 Mussoorie; 1 Pologround, 1 Dhanaulti, 3 Dakuri, 1 Almora, 1 Nainital, 1 Pilibhit, U.P.; 1 Bans Bihari, 1 Hathiban, 2 Nepal Valley; 2 Temi, W. Sikkim; 1 Gedu, West, 1 Wamrong, East Bhutan; 2 Kurseong, 7 Long View Tea Estate, Darjeeling, Bengal.

Measurements on p. 78.

1751 **Turdus merula intermedius** (Richmond) (Aksu, E. Turkestan) Turkestan Blackbird

2: 1 male 1 female

1 *Baghdad, Iraq; 1 Tashkent, U.S.S.R.*

Both birds are jet black all over and larger than the others in their group.

Measurements on p. 78.

1752 **Turdus merula maximus** (Seebohm) (Cashmere, restricted to Gulmerg) Tibetan Blackbird 2:123

3: 1 Male 1 female 1 (?)

2 Nila Valley; 1 Truseum, Garhwal, U.P.

Measurements on p. 79.

1753 **Turdus merula nigropileus** (Lafresnaye) Neilgherries, restricted to Kalhatti, northern Nilgiri Plateau) Blackcapped Blackbird 2:128

38: 22 males 9 females 7 (?)

1 Kumaon, Naini Tal dt., 2 Cambay City environs, 1 Pawagadh (Panchmahal dt.); 7 Panchgani, 1 Poona; 1 Pali Hill, Bombay, 1 Uran, 1 Karnala Hill, 1 Matheran, 1 Khandala; 1 Koyna Valley; 2 Lanja, 3 Mahableshwar; 1 Ratnagiri, 1 Molem, Goa; 2 Savantvadi; 2 Karwar, 2 Murgimatta, Sagar, 1 Kuriarkutty, 1 Merchistan, Ponmudi, 1 Thekkady, Periyar Lake, 1 Thattakkadu, Travancore; 1 Horabail village, Ulavi, 1 Kunnapalli, Nilgiris; 1 Kanha Tiger Reserve, M.P.

Measurements on p. 79.

1754 **Turdus merula spencei** Whistler & Kinnear (Jeypore Agency) Eastern Ghats Blackbird

6: 3 males 2 females 1 (?)

2 Ratnagiri; 1 Nallamalai Range, S. Kurnool, 1 Seshachalam Hills, S. Cuddappa, 1 Sankrametta, 1 Jeypore Agency.

Measurements on p. 79.

1755 **Turdus merula simillimus** Jerdon (Neilgherries restricted to Avalanche, higher southern Nilgiri Plateau) Nilgiri Blackbird 2:125

4: 3 males 1 female

1 Ootacamand, 1 Ketti, 1 Avalanche, 1 Naduvattom, Nilgiris.

These are darker than *bourdilloni*, which are in various stages of plumage but distinctly paler most of them being spotted all over.

Measurements on p. 79.

1756 **Turdus merula bourdilloni** (Seebohm) (Travancore = Colathoorpolay Patnas, Travancore) Bourdillon's Blackbird 2: 127

21: 13 males 6 females 2 (?)

1 Valpoi, Goa; 1 Anamalai High Range, 1 Munnar, 1 Devikulam, 1 Muthukuzi, Ashambu Hills, 1 Madurai; 11 Shembaganur, 3 Kodaikanal, 1 Palni Hills.

The bird from Goa (10 Dec. 1979) has a black bill and may be one that has strayed from the breeding range of the race.

Measurements on p. 79.

1757 **Turdus merula kinnisii** (Kelaart) (Newera Elia) Ceylon Blackbird 2:126

2: 1 male 1 female

1 Hakgalla, 1 Awant, Ceylon.

Measurements on p.

EL **Turdus merula merula** Linnaeus (Sweden) Blackbird

2: 1 male 1 (?)

2 *Budapest, Hungary.*

Measurements on p. 79.

EL **Turdus merula syriacus** Hemprich & Ehrenberg

10: 2 males 7 females 1 (?)

1 *Baghdad, Iraq;* 1 *Mosul,* 3 *Shiraz,* 3 *Meshed,* 2 *Legation Gulak, Tehran, Iran.*

Measurements on p. 79.

1758 **Turdus rubrocanus rubrocanus** G.R. Gray (Nepal) Western Greyheaded Thrush 2:132

13: 7 males 3 females 3 (?) (1 juv.)

1 Dunga Galli, 1 Dosoo, Kashmir; 1 Tara Devi, Patiala St., 1 Keonthal St. 8 Simla N.W.H; 1 Mountains N.W. of Mussoorie.

The females lack the white collar which turns from grey to pure white in the males.

Measurements on p. 79.

1759 **Turdus rubrocanus gouldii** (Verreaux) (W. Setchuan) Gould's Greyheaded Thrush 2:133

nil.

1760 **Turdus kessleri** Przevalski (Kansu) Kessler's Thrush 2: 134

nil.

1761 **Turdus feai** (Salvadori) (Mulayit Mts., Tenasserim). 2: 143

nil.

1762 **Turdus obscurus** Gmelin (Siberia = Lake Baikal) Dark Trush 2:141

7: 3 males 1 female 3 (?)

2 Pt. Calimere, Tanjore dist: 1 Maya Bunder, Andamans; 2 Narcondam Is; 1 *Legon, Henzada, Burma;* 1 *Malacca.*

The birds from Pt. Calimere are not included in the Eastern Ghats nor in other lists from Pt. Calimere, the only record from Peninsular India being one from Belgaum. Those from Narcondam Island have been included in Abdulali's list of birds from this island.

Measurements on p. 79.

1763 **Turdus ruficollis atrogularis** Jarocki (Poland) Blackthroated Thrush 2:137

66: 37 males, 25 females 4 (?)

1 *Amirabad Berijand, Persia,* 5 *Sultanabad,* 8 *m s. of Shiraz,* 1 *Meshed, Persia,* 3 *Pir-e-Banu,* 9 *m. s. of Shiraz,* 2 *Bagh-i- Jaunat,* 4 *m s.w. of Shiraz,* 1 *Bagh-Raz-i;* 4 Chitral, 1 Wana, 1 Datta Khel, Waziristan; 1 Chaman, 2 Quetta, 1 Kashmir, Upper Sind Frontier, 1 Pithoro Sind, 1 Bahawalpur Town env., 1 Campbellpur, W. Punjab; 12 Simla, 1 Koti state, 1 Keonthal state; 1 Mussoorie, 2 Mornaula, Kumaon, 1 W. Kumaon, 1 Almora, 1 Dwarkanath, Almora, 1 Ambala, 1 Delhi, 1 Rajpur, Barwani St., C.I., 1 Swaliks, 1 Salukapur, Kheri dist; 1 Baghownie, 1 Isanagar, 2 Tirhut, Darbhanga dt.; 1 Bhutan Duars, 1 Kurseong, 1 Roopchena, 1 N. Cachar, 1 Gyantse, 1 Temi, W. Sikkim; 2 Goalpara, 2 Margherita, Assam; 1 Kalaktang, Arunachal Pradesh.

Measurements on p. 79-80.

1764 **Turdus ruficollis ruficollis** Pallas (Dauria) Redthroated Thrush 2:136

23: 14 Males, 8 females 1 (?)

1 Lachen, N. Sikkim, 3 Khasia Hills, 2 Mishing Abor Country; 16 *Temple of Heaven, Peking, China,* 1 no data.

Measurements on p. 80.

1765 **Turdus naumanni eunomus** Temminck (Japan) Dusky Thrush 2:133

4: 1 male, 2 females, 1 (?)

1 Margherita, Assam; 1 Sarun, Bengal; 2 *Temple of Heaven, China.*

Measurements on p. 80.

1766 **Turdus pilaris** Linnaeus (Sweden) Fieldfare 2:155

3: 1 male, 2 females

1 *Niton, Isle of Wight,* 1 *Whittlesford, Cambs, U.K.;* 1 *USSR.*

Measurements on p. 80.

1767 **Turdus iliacus** Linnaeus (Sweden) Redwing

1 (?) (in very poor condition), *Niton, Isle of Wight*

1768 **Turdus viscivorus bonapartei** Cabanis (Himalayas) Mistle Thrush

20: 9 males, 8 females , 3 (?)

3 Chitral, 1 Sonamarg, 1 Pyas, Kishtwar, 1 Liddar Valley, Kashmir; 2 Keonthal State, 2 Simla, 3 Simla Hills, 1 Cho Mountain, Simla Hills, 1 Dehradun, 2 Mornaula, 1 Bhim Tal, Kumaon, 2 Garhwal.

EL. **Turdus viscivorus viscivorus**

5: 1 male, 2 females 2 (juv.)

2 *Niton, Isle of Wight,* 2 *Cambs,* 1 *Kain, Persia*

EL. **Turdus ericetorum philomelus** Brehm (Middle Germany)

11: 3 males, 3 females, 5 (?)

1 *Tigris,* 3 *Hawiplain Samara,* 1 *Fahama,* 2 *Shustar,* 2 *Sultanabad,* 8 *m s. of Shiraz,* 1 *Bander Mahshahr, Iran;* 1 *Mosul, Persia.*

PART 34

	Wing	Bill	Tarsus	Tail
	1731 Zoothera wardii			
Male 3	111, 115, 117	19.8, 20.3, 21	24.5, 26.5, 27.3	72, 74, 75
	(IH 110–119	from skull 25–28	26–28	75–79)
Female 2	113, 118	20, 22	24.3, 27	73, 76
	(IH 110–120	from skull 25–28	26–28	74–82)
	1732a Zoohtera sibirica davisoni			
Male 2	116, 123	18.5, 19.3	27.5, 30	80, 83
Female 1	120	18.8	28.5	85
	(Baker M–F 119–128	*c.* 20	*c.* 30	87–90)
	1733–36 Zoothera citrina subspp.			
1733 male *citrina*(10)	112–120 av. 116.6	19–21.2 av. 19.7	27.5–33.1 av.30.4	68–74 av. 69.5
	(IH 113–126	from skull 23–25	29–33	70–83)
1734 *cyanotus* (14)	100–114 av. 108.6	19–20.7 av. 19.7	28.5–31.5 av. 29.8	61–78 av. 68.1
	(IH 106–119	from skull 20–25	20–33	72–80)
1734a *amadoni* (11)	108–117 av. 112.5	18.2–20.5 av. 19.2	29.5–32.7 av. 30.9	66–76 av. 70
1735 *andamanensis* (5)	103–110 av. 106	17–19.7 av. 18.6	30.5–31.6 av. 31	65–73 av. 70.2
	(Baker M–F 100–107	–	30–31	70–71)
1736 *albogularis* (3)	95, 100, 105	19, 19.3, 19.4	21.3, 21.5, 24.5	68, 70,–
	(Baker M–F 100–106	–	*c.* 31	66–72)
1733 female *citrina* (6)	105–120 av. 113.1	18.4–21.2 av. 19.5	27.5–32 av. 29.5	66–73 av. 69.2
	(IH 114–123	from skull 23–25	29–33	72–81)
1734 *cyanotus* (9)	102–111 av. 106.3	18–20 av. 18.9	27.8–30.9 av. 29.2	63–76 av. 69.3
	(IH 102,–116	from skull 20,–25	28–29	67–77)
1734a *amadoni* (7)	105–117 av. 109.8	16.5–20.8 av. 18.8	25–31.3 av. 28.8	66.72 av. 69–.7
1735 *andamanensis* (1)	102	17.7	27	72
	(Baker M-F 100-107	–	30–31	70–71)
	1738–39 Zoothera mollissima subspp.			
Male				
1738 *whiteheadi* (2)	135, 146	–22.4	–37.1	81, 97
	(IH 140	from skull 26	36	97)
1739 *mollissima* (6)	140–145 av. 142.6	20.5–24.6 av. 22.3	28.5–38.4 av. 32.2	85–97 av. 91.3
	(IH 141–146	from skull 25–26	37–39	98–99)
Female				
1738 *whiteheadi* (5)	134–145 av. 138.4	20.1–22.8 av. 21.7	34.1–37 av. 34.8	79–88 av. 84
	(IH 143	from skull 26	36	102)
1739 *mollissima* (3)	136, 138, 143	21, 21.3, 22.5	35, 35, 35.7	84, 84, 90
	(IH 134–144	from skull 25–26	36–37	91–96)
	1740 Zoothera dixoni			
Male 5	135–136 av. 135.8	20–22.6 av. 21.7	34.5–38.4 av. 36.7	95–111 av. 99.2
	Vaurie (M-F 131–146	from skull 26–29	–	94–110)
Female 1	136	23.2	36.2	96
	1741–44 Zoothera dauma subspp.			
Male				
1741 (a) *dauma* 8 pale	140–147 av. 144	22–25.1 av. 23.3	27–33.4 av. 30.6	83–98 av. 89.8
1741 (b) *dauma* (4) dark	140–145 av. 142.7	22.7–24.7 av. 23.5	30.2–33.5 av. 31.1	84–95 av. 89.7
	(IH 137–150	from skull 26–31	34–36	91–107)

	Wing	Bill	Tarsus	Tail
Female				
1741 (a) *dauma* (4) pale	138–144 av. 141.5	23.1–24.5 av. 23.5	31.3–33.5 av. 32.4	89–95 av. 91.5
1741 (b) *dauma* (6) dark	137–145 av. 140.5	21.1–22.9 av. 21.8	30.1–33.1 av. 31.9	83–98 av. 92.3
	(IH 135–150	from skull 21-29	34–35	97–102)
Female				
1742 *neilgherriensis*	(1) 130	26.2	28.5	82
	(Baker M–F 124–136	27–29	28–29	81–92)
1744 *aurea* (1)	144	24.2	32.9	85
	(IH MF 151–165	from skull 27–31	–	112–118)
		1745 Zoothera monticola		
Male				
(5)	142–152 av. 146.8	33.3–37 av. 34.6	30–32.3 av. 31.3	72–80 av. 77.2
	(IH 1321–150	from skull 41–46	35–36	78–93)
Female				
(2)	142, 146	32.2, 34.5	33, 34.5	74, 81
	(IH 130–141	from skull 41	–	83)
		1746 Zoothera marginata		
Male				
(2)	124, 127	24.5, 30	27.7, 29	68 (2)
	(Koelz M F 122–130	–	–	–)
Female				
(2)	116, 126	24.9, 26	24.2, 25.5	63, 64
	(IH 124–129	from skull 33–34	28–30	68–78)
		1747 Turdus dissimilis		
Male				
(4)	115, 116, 117, 118	18.1, 19, 19.9, 20.4	28, 29.5, 31.8 (2)	72, 75 (2), 76
	(IH 122, 123	from skull 25	32	78, 81)
		1748 Turdus unicolor		
Male				
(14)	114–130 av. 122.2	17.2–20.2 av. 18.8	25.2–31 av. 27.6	76–86 av. 81.4
	(IH 116–130	from skull 22-24	29–32	75–95)
Female				
(12)	111–131 av. 118.8	16.5–20.8 av. 18	24.9–30 av. 27	71–91 av. 78.3
	(IH 113–123	from skull 22–24	29–32	74–85)
		1749 Turdus albocinctus		
Male				
(13)	133–145 av. 139	22.3–25.2 av. 23.7	27.2–36.4 av. 32–1	80-113 av. 101
	(IH 137–151	from skull 29–30	*c.* 35	101–109)
Female				
(7)	134–140 av. 136.2	20.7–24.4 av. 22.8	29.5–36 av. 32.3	89–105 av. 99.7
	(IH 131,196143	from skull 27	*c.* 34	95–111)
		1750 Turdus boulboul		
Male				
(25)	141–153 av. 147.3	22.3–26.7 av. 23.8	28–35 av. 31	95–122 av. 107.2
	(IH 140–151	from skull 27–30	35–37	107–122)
Female				
(17)	133–155 av. 142.5	21.2–27.7 av. 23	29–32.2 av. 30.5	95–110 av. 102.8
	(IH 131–148	from skull 26–37	35–37	100–114)
		1751-57 & ELs **Turdus merula** subspp.		
Male				
1751 *intermedius* (1)	139	22.5	26.5	110
	(IH 130–140	–	–	120–130)

	Wing	Bill	Tarsus	Tail
1752 *maximus* (1)	161 (IH 144, 161	25.9 from skull 25–29	32.3 *c.* 38	134 107–120)
1753 *nigropileus* (22)	118–143 av. 127.1 (IH 126–135	20.3–24.3 av. 22 from skull 25–28	26.5–36 av. 29.6 30–35	84–103 av. 91.9 92–101)
1754 *spencei* (3)	121, 125, 126 (IH 122–132	21, 21.5, 22.7 from skull 25–26	26.5, 28, 29 30–33	89, 92, 96 91–102)
1755 *simillimus* (3)	127, 130, 130 (IH 120–124	21.4, 22.6, 24.5 from skull 25–28	29.6, 31.5, 32.2 31–34	96, 97, 97 96–100)
1756 *bourdilloni* (a) (8)	118–132 av. 126.5	20.4–23.5 av. 22.3	26.7–31.5 av. 29.3	81–106 av. 94.7
(b) (4)	118–129 av. 123.2 (IH measurements as in 1755)	21.4–24.5 av. 23.1	27–32.1 av. 29.5	92–98 av. 95
1757 *kinnisii* (1)	115 (IH 104–119	19.8 from skull 24–26	27.3 31–33	95 85–100)
	EL *merula* (1) (Dementiev 123–138	122 19–22	19.5 –	29.795 105–115)
EL *syriacus* (2)	120, 127	21.5, 21.5	30, 30.7	105, 114
Female				
1752 *maximus* (1)	147 (IH 144–153	27.2 from skull 25–28	37 *c.* 38	131 107–120)
1753 *nigropileus* (10)	121–138 av. 124.6 (IH 116–129	20.5–24 av. 22 from skull 25–28	25–29 av. 27.3 30–33	75–105 av.79.8 84–98)
1754 *spencei* (2)	125, 126	21, 22	23.3, 25	84, 87
1755 *simillimus* (1)	122 (IH 119–122	20.5 from skull 26–28	31.8 31–34	93 93–98)
1756 *bourdilloni* (a) (4)	118–129 av. 122	21.8–22.3 av. 21.9	28.8–31 av. 29.5	83–97 av. 89
(b) (1)	121 (IH measurements as in 1755)	22.1	30.7	93
1757 *kinnisii* (1)	112 (IH 105–116	19.5 from skull 24–26	29.5 30–33	92) 81–92)
EL *syriacus* (7)	122–131 av. 125.7	20.3–24.5 av. 22.7	27.6–32.3 av. 30.1	92–114 av. 104.7

1758 Turdus rubrocanus rubrocanus

	Wing	Bill	Tarsus	Tail
Male				
(7) 1 juv.	133–144 av. av. 137.8 (IH 135–144	20.5–23 av. 21.8 from skull 30	27.6–31.2 av. 29.7 33	100–109 av. 105.5 110)
Female				
(3) 1 juv.	132, 135, 137 (IH 132–135	21.3, 22.5, 22.8 –	28, 29.5, 30.9 –	94, 110, 112 –)

1762 Turdus obscurus

	Wing	Bill	Tarsus	Tail
Male				
(4)	123–132 av. 126.7 (IH 120–136	17.9–19.8 av. 18.8 from skull 21–23	27.3–32.8 av. 29.5 31–33	78–86 av. 81.5 84–91)
Female				
(2)	118, 130 (IH 116–125	16.8. 17.5 from skull 21–23	28.6, 28.7 31–33	82, 85 84–91)

1763–64 Turdus ruficollis subspp.

	Wing	Bill	Tarsus	Tail
Male				
1763 *atrogularis* (37)	132–145 av. 137 (IH 127–143	17–19.9 av. 18.5 from skull 22–25	26–34.4 av. 31.1 32–35	84–103 av. 93.4 89–104)
1764 *ruficollis* (14)	128–140 av. 133.6 (IH 128–143	16.7–20 av. 18.2 from skull 22–23	27–31.5 av. 28.8 34–35	80–96 av. 91.5 94–106)

	Wing	Bill	Tarsus	Tail
Female				
atrogularis (25)	125–138 av. 132.8	16–20.5 av. 18.6	25.7–34 av. 30.1	80–95 av. 88.8
	(IH 125–138	from skull 22–25	32–35	89–104)
ruficollis (8)	123–148 av. 130	17.1–19.6 av. 18.7	28.5–31.5 av. 30	70–97 av. 86.6
	(IH 127 –136	from skull 22–23	34–35	94–106)
		1765 **Turdus naumanni eunomus**		
Male				
(1)	128	16.8	31.4	78
	(Dementiev 124–134	–	–	95–98)
Female (2)	127, 130	17.1, 17.4	30, 31.4	86, 86
	(Dementiev 121–133	–	–	95–98)
		1766 **Turdus pilaris**		
Male				
(1)	148	17.8	30	98
	(Dementiev 137-153	–	–	110–115
Female				
(2)	135, 145	17.8, 18.2	28.3, 29	98, 100
	(Dementiev 133–148	–	–	110–115)
		1767 **Turdus iliacus**		
Female				
(1)	113	16.3	26.6	78
	(Dementiev 108–116	–	–	*c.* 80)
		1768 **Turdus viscivorus** subspp. & EL		
Male				
1768 *bonapartei* (9)	156–167 av. 161.5	20–23.6 av. 22	28.2–33.8 av. 31.3	100–120 av. 110.6
	(IH 162–172	from skull *c.* 27	36–38	116)
EL *viscivorus* (1)	156	19.6	26.6	106
	(BHB 145–160	from skull 22–25	30–35	100–117)
Female				
bonapartei (8)	155–167 av. 160.2	20.5–23.2 av. 21.8	29.2–33.3 av. 30.6	106–110 av. 108.5
	(IH 157–168	from skull *c.* 27	36–38	112)
EL *viscivorus* (2)	145, 155	20.7, 21.9	28, 29.3	95, 110
	(BHB 145–157	–	–	–)
		EL **Turdus ericetorum philomelus**		
Male				
(3)	117, 118, 119	16.6, 16.9, 17	27.7, 28.5, 30.2	79, 80, 80
	(BHB 111–121	from skull 20–23	31–35	77–90)
Female				
(3)	112, 116, 117	16.6,16.8, 17	29, 30, 30	77, 78, 80
	(BHB 111–121	–	–	–)

NEW DESCRIPTIONS

DEMANIA SHYAMASUNDARII, A NEW SPECIES OF CRAB (DECAPODA : BRACHYURA) FROM THE WALTAIR COAST OF BAY OF BENGAL[1]

K. NIRMALA DEVI[2]

(With nine text-figures)

INTRODUCTION

The diagnostic characters of the genus *Zozymus* Leach were given by Alcock (1898). Alcock (1898) also gave the key to the Indian species of *Zozymus* and described them. Although the present species bears some resemblances to *Zozymus aeneus* (Linn.), detailed study revealed that it belongs to the genus *Demania* Laurie, 1906. Laurie (1906) gave the diagnostic characters of the genus *Demania* and cited its differences from those of *Zozymus*. He then described a new species, *Demania splendida*, collected by Herdman (1902) at Ceylon (Sri Lanka). In 1969, Guinot revised the genus *Demania* and described a new species. Later, in 1979, Guinot gave the diagnostic characters for all the eight species so far described.

Demania shyamasundarii sp. nov.

Holotype: Male – breadth 30 mm, length 19 mm, front 9 mm.

Paratypes: (1) Female, breadth 24 mm, length 18 mm and front 7 mm. (2) Female, breadth 29 mm, length 17 mm and front 7 mm. (3) Female, breadth 27 mm, length 17 mm and front 7 mm. (4) Female, breadth 24 mm, length 17 mm and front 7 mm. (5) Male, breadth 29 mm, length 18 mm and front 7 mm. (6) Male, breadth 27 mm, length 17 mm and front 7 mm. (7) Male, breadth 29 mm, length 19 mm and front 8 mm. (8) Male, breadth 35 mm, length 21 mm and front 9 mm. (9) Male, breadth 29 mm, length 19 mm and front 8 mm. (10) Male, breadth 28 mm, length 19 mm and front 7 mm.

Average measurements: Breadth 29 mm, length 17 mm and front 7 mm.

Collected at offshore fishing station, Visakhapatnam during 1979-1980. The holotype and paratypes are now in the Zoology Museum of Andhra University, Visakhapatnam. They will be deposited in the Museum of Zoological Survey of India, Calcutta.

Colour during life: Carapace and chelipeds brick-coloured, legs white with brick-coloured spots, lobules of carapace with white ocelli. In formalin it is creamy white in colour and the white ocelli have disappeared.

Anterior half of the carapace including front forms a semi- circular outline. Antero-lateral borders convex, postero-lateral borders straight and convergent, posterior border slightly concave.

Carapace convex at the centre from side to side but flat at the posterior region. Regions are well marked by the grooves and each region is subdivided into lobules by similar grooves. The grooves deep, smooth, without any ornamentation but covered by pubescence. The lobules smooth, polished but dimpled, the lobules distinct and somewhat bulging; in the posteriormost region of the carapace, the lobules are numerous, small, like large tubercles (Fig. 1).

Front clearly demarcated and divided into two distinct lobes by a central groove. Anterior border of frontal lobes slightly oblique, almost at the same level of the orbits, its breadth almost about one-fourth of the greatest breadth of the carapace.

Frontal breadth ÷ Carapace length (9 ÷ 19) = 0.47

Length of frontal lobe (inner border) ÷ frontal breadth (2 ÷ 8) = 0.25

Orbital border smooth, tumid. There are three fissures on the upper border, one at the middle, the second between front and inner angle of orbit, the third between first antero-lateral lobe and outer angle of the orbit. Eyes pale brown, on short thick stalks.

The antero-lateral border convex forms an angle with postero-lateral border, divided into four lobes by grooves. First two lobes smaller than the last two lobes. The grooves distinct, border of lobes

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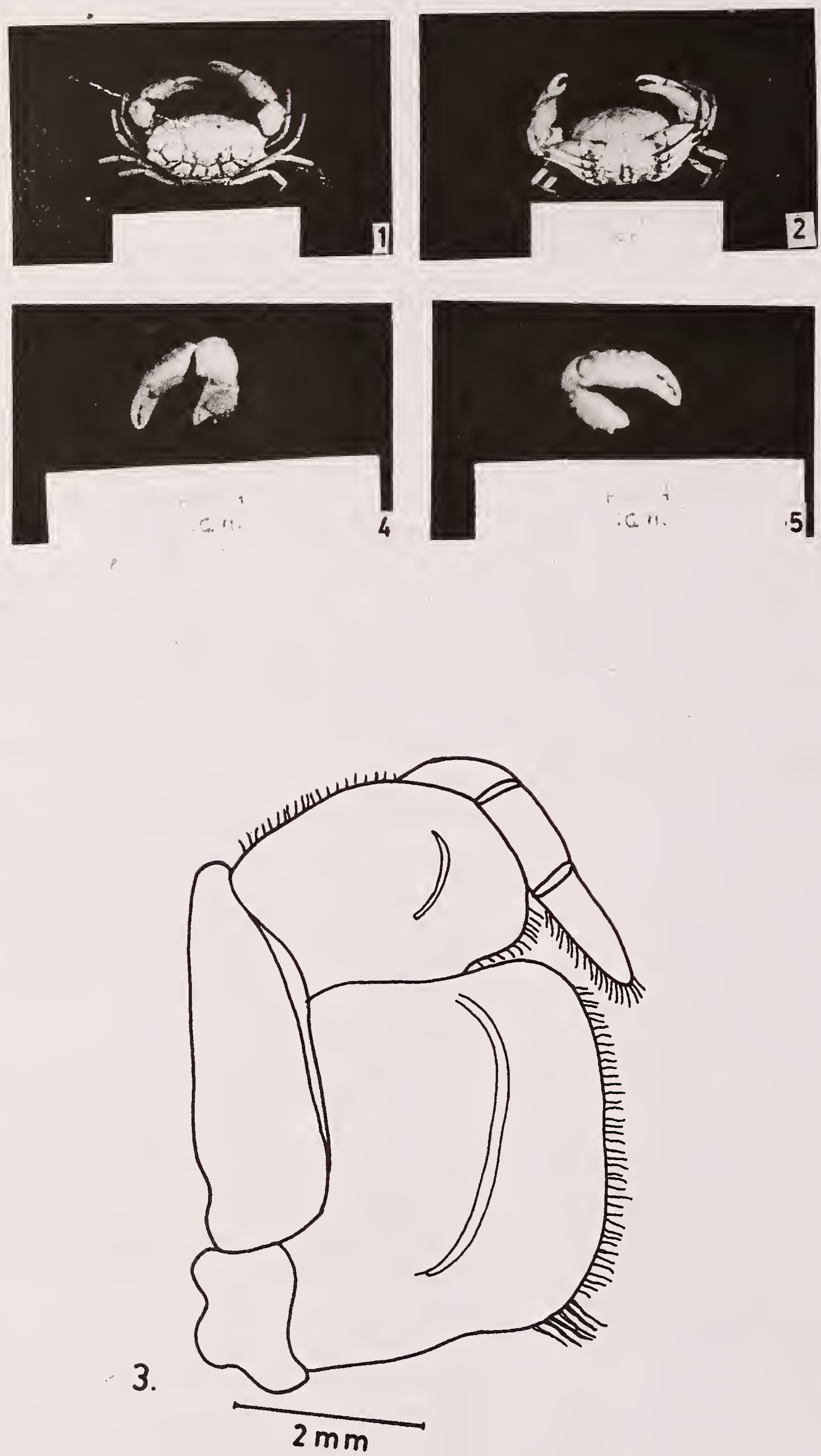


Figs. 1-5. *Demania shyamasundarii* sp. nov.
1. Dorsal view, 2. Ventral view, 3. Third maxilliped (right side), 4. Chelate leg (under surface), 5. Chelate leg (upper surface),

TABLE 1
DIFFERENCES BETWEEN *Demania splendida* LAURIE AND *D. shyamasundarii* SP. NOV.

	Demania splendida Laurie, 1906	*Demania shyamasundarii* sp. nov.
1.	Lobules of smooth and polished.	Loubles of carapace smooth, polished but dimpled.
2.	Front considerably produced, forming two prominent, bluntly pointed lobes.	Front divided into two distinct lobes which are at the same level of the orbit, without forming any pointed lobes.
3.	Fissures on upper border of orbit, one a little to outer side of middle point of upper border, the other two in the neighbourhood of the outer angle.	One at the middle, second between front and inner angle of orbit, and third between outer angle of orbit and first anterolateral lobe
4.	Undersurface of carapace smooth, polished and lobulated	Undersurface of carapace rough, with granules.
5.	Hairs on inner border of ischium and merus not present in the illustration given by Laurie (1906). Surface of external maxillipeds polished.	Inner border of ischium and merus bears small hairs. Surface of external maxillipeds polished but with some dimples.
6.	Transverse grooves of hand crossed by two longitudinal grooves.	Transverse grooves of hand are traversed by three longitudinal grooves.
7.	Inner anterior angle of wrist with a tooth, to the inner side of which is a much smaller one.	Inner anterior angle of wrist with a tooth, smaller tooth not seen.
8.	Regular pubescent groove running along proximal portion of upper surface of dactylus.	This groove is not seen on the surface of the dactylus
9.	Crest present on dorsal borders of uropodite, carpopodite and propodite	Crest absent
10.	Propodite of 4th walking leg foliaceous.	Propodite of 4th walking leg not foliaceous, but similar to other walking legs.
11.	Tuft of hairs on dorsal border of proximal portion of meropodite of each walking leg.	Tuft of hairs absent on dorsal proximal portion of meropodite.
12.	The figure of first pleopod of male given by Guinot (1979), has no long hairs on both borders.	A short distance below the tip, both borders bear long hairs.

smooth convex, surface dimpled. There is an indication that anteriorly it continues below the inner border of the orbit, to the anterior external angle of the buccal cavern. Undersurface of carapace rough, with minute granules. Pubescence at the base of chelate legs and pereopods.

Thoracic sternal region on either side of the abdomen is broken by pubescent grooves into regions similar to the segments bearing the chelipeds and pereopods. Surface polished but has some dimples (Fig. 2).

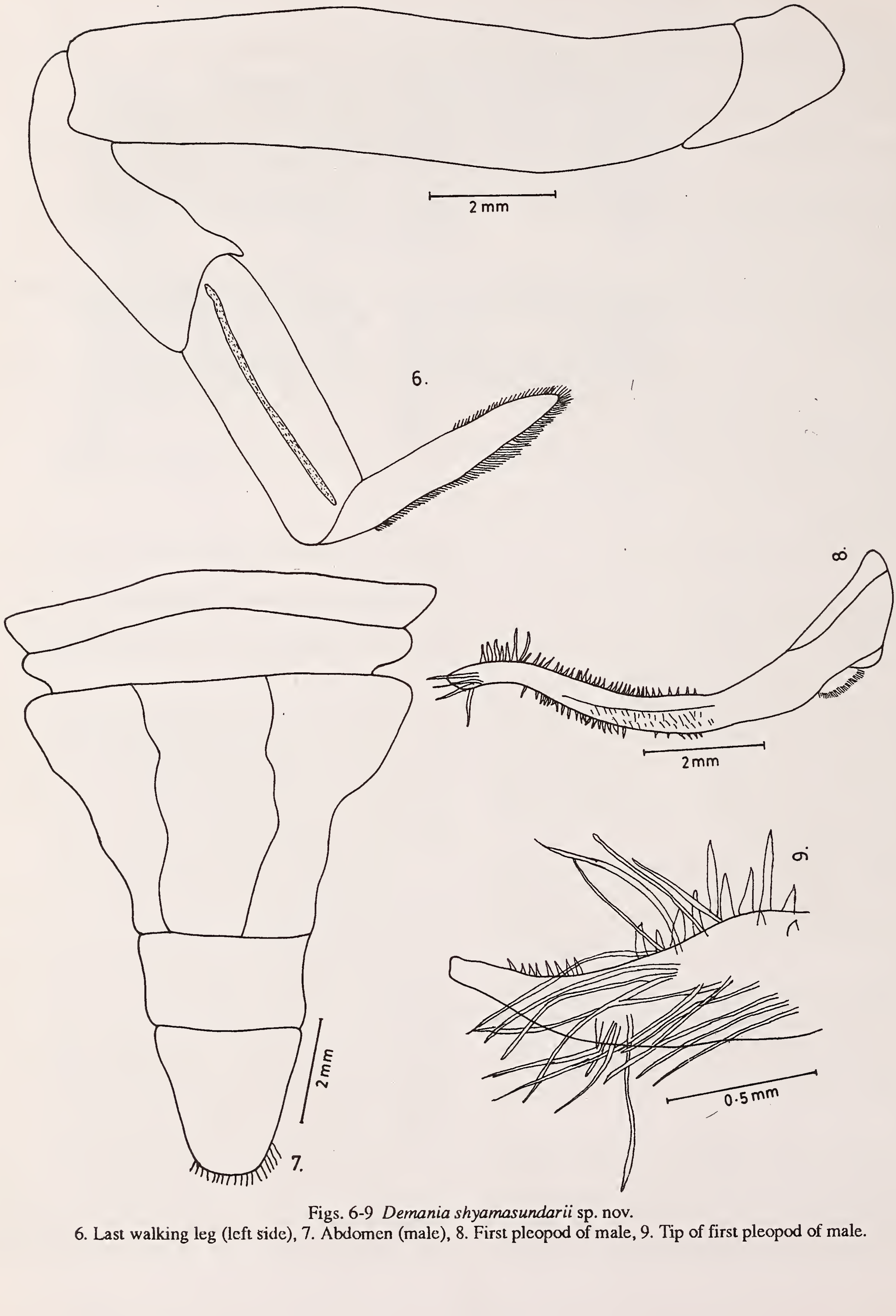
Basal antennal joint short, present in the inner orbital angle, its inner angle touches the downward growth of the front and outer angle juts into the orbital hiatus. Flagellum short, lying in the orbital hiatus and smaller than the diameter of the orbital hiatus.

Antennules fold obliquely, forming an angle of 40° (approximately) with a horizontal line. Interannular septum broad. Merus of third maxilliped is as broad as the ischium. But the length of the merus is half that of ischium. A longitudinal furrow traverses the ischium; this is less distinct on the merus. The inner borders of ischium and merus bear hairs. The inner border is oblique, bent backward, surfaces of ischium and merus polished but have some dimples. Flagellum arises from the apex and extends up to the anteriormost region of the ischium (Fig. 3).

Outer border of pterygostome serrated.

Chelipeds of equal size in female but the right slightly larger in male.

The upper surface of the wrist and hand have transverse grooves and bear large tubercle-like structures arranged transversely. The transverse grooves of hand are traversed by three not so deep longitudinal grooves, one extending to the base of the movable finger, the second to the base of the interdigital cleft and the third to the base of the immovable fingers. The upper surface of arm shows two transverse grooves —one deep groove below its anterior end, and the second (which is not so deep) below the first. Undersurface of the arm smooth, concave in correlation with the convex undersurface of the carapace (Fig. 4). The upper border of arm has



Figs. 6-9 *Demania shyamasundarii* sp. nov.
6. Last walking leg (left side), 7. Abdomen (male), 8. First pleopod of male, 9. Tip of first pleopod of male.

three blunt teeth and is lined by short hairs. The greatest breadth and length of the upper surface of wrist are almost equal. At the inner anterior angle is a large tooth. The inner border of hand has six large tubercles extending from the junction of wrist and hand to base of the movable finger (Fig. 5). Fingers have blunt tips. The immovable finger has four teeth which fit into the concavities of the movable fingers which has the same number of teeth. At their base there is a gap but at their tip the first two teeth fit tightly into the concavities when the fingers are shut.

Walking legs flattened laterally. The surface of all the walking legs polished. The length of the walking legs decreases gradually from first to last leg. A faint longitudinal groove is present in the middle of both surfaces of the propodus of all legs. Small dimples present on the polished surface of the walking legs. Dactylus is narrower than the remaining segments and tapers gradually towards the tip. The upper border of dactylus is bordered by hair throughout but the hairs extend only from the middle to the tip on the lower border (Fig. 6).

In the male, abdomen has five segments only, 3rd to 5th segments being fused to form a composite segment. Along the composite segment run two longitudinal grooves. The sixth segment is broader than long, triangular, tip rounded and bordered by hairs. Abdomen of female has seven segments; length of the segments increases gradually from first to seventh. Seventh triangular, with round tip. Two faint longitudinal grooves extend from first to sixth segments (Fig. 7). Abdomen is well fringed with hair. The groove covered by the abdomen is finely granular.

First pleopod of male stout, long and curved in the middle (Fig. 8). Tip is blunt and bare. Below the tip both borders have long hairs, and the inner border also bears spines (Fig. 9).

Discussion

The present species shows some similarities with *Zozymus aeneus* (Linn.) and *Demania splendida* Laurie, 1906, but has a closer resemblance to the latter.

The similarities are: (1) Antero-lateral borders of carapace convex, (2) posterior border of carapace concave, (3) lobules of carapace smooth, (4) structure of upper border of orbit, (5) thoracic sternal region, (6) folding of antennules, (7) general structure of external maxilliped, and (8) structure of the chelipeds. The differences are shown in Table 1.

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References

Alcock, A. (1898):Materials for a carcinological fauna of India. No. 3. The Brachyura Cyclometopa. Part I. Family Xanthidae. *Jour. As. Soc. Bengal* IXVII: 67-233.

Guinot, D. (1969): Sur divers Xanthidae, notamment sur *Actaea* de Haan et *Paractaea* gen. nov. (Crustacea, Decapoda, Brachyura). *Cah. Pacif. no. 13:* 222-267, figs. 1-36.

Guinot, D. (1979): Morphologie, phylogeneses et taxonomie des Brachyoures. *Bull. Mus. Hist. nat. Paris 112:* 57-61.

Laurie, R.G. (1906): On the Brachyura. Report ceylon pearl oyster fisheries of the Gulf of Mannar by W.A. Herdman. Supplementary Report No. XL.

PATIALUS, A NEW GENUS OF SUBFAMILY CIONINAE FROM INDIA AND THE DESCRIPTION OF A NEW SPECIES (CURCULIONIDAE: COLEOPTERA)[1]

H.R. PAJNI[2], DALIP KUMAR AND H.S. ROSE[3]

(With a text-figure)

Patialus tecomella, a new species under a new genus of subfamily Cioninae has been described. The diagnostic features of the new genus have been included.

INTRODUCTION

During the course of extensive collections under the two 5-year PL-480 projects on Indian Curculionidae, we collected six species of subfamily Cioninae. One of the species marks the record of a new genus from this country. The important characters of the new genus, *Patialus*, and complete description of the new species, *tecomella*, are given in this communication. The Indian material of this subfamily is so far represented by eight species under the genus *Cionus* Clairv. (Klima 1934).

OBSERVATIONS

The subfamily Cioninae includes medium sized curculionids with five segmented funicle and concealed pygidium. The abdominal sternites 2-4 are curved backwards on lateral sides.

The subfamily includes four Oriental genera, out of which only *Cionus* Clairv. has been recorded from this country. The new genus has paired tarsal claws but carries a canal on the sternum that runs up to the middle of mesosternum. The prosternum of the two known genera with paired claws is not canaliculated. The prosternum is canaliculated in the genus *Stereonychidius* Morimoto which, however, falls in the category of the single clawed genera. A revised key to the Oriental genera, as modified from Morimoto (1962), is given

A KEY TO THE ORIENTAL GENERA OF SUBFAMILY CIONINAE

1. Tarsus with a single claw 2
– Tarsus with paired claws 3
2. Fore-coxae separated. Prosternum canaliculated *Stereonychidius* Morimoto
– Fore-coxae contiguous. Prosternum flat or depressed ....*Stereonychus* Suffrian
3. Prosternum canaliculated .... *Patialus* Gen. nov.
– Prosternum non-canaliculated 4
4. Elytra with a sutural spot
Tibiae unarmed in both sexes; claws equal in female,inner claw shorter than outer one in male ....*Cionus* Clairville
– Elytra without a sutural spot.
Tibiae mucronate in male; claws of same length in both sexes ....*Cleopus* Stephens

Patialus gen. nov.

Head large, coarsely punctate; frons broad; eyes large, ovate. Rostrum as long as pronotum. Antennae inserted at apical one- third of rostrum; funicle with segment 2 longer than 1. Prothorax transverse, with basal margin bisinuate. Elytra oblong; striae narrow; intervals much broader than striae. Hind femora not exceeding elytral apices, each armed with short tooth. Prosternal canal reaching up to middle of mesosternum. Abdominal sternite 1 longer than 2 and 3 combined. Male genitalia with aedeagal apodemes as long as aedeagus; endophallus with rod-shaped flagellum; phallobase with parameres. Female genitalia with coxites tubular; spermatheca with collum and ramus indistinct.

Type-species: *Patialus tecomella* sp. nov.
Distribution: India.

Patialus tecomella sp. nov. (Fig. 1)

Head piceous, moderately shiny, closely punctate, covered with dark brown broad scales sparsely variegated with dull whitish narrow scales; frons with median shallow depression; eyes blackish with golden tinge, ovate. Rostrum rufus, stout, as long as prothorax, laterally compressed, gently widened after antennal insertion towards wedge-shaped apex; surface coarsely punctate, covered with dark brownish scales up to antennal insertion

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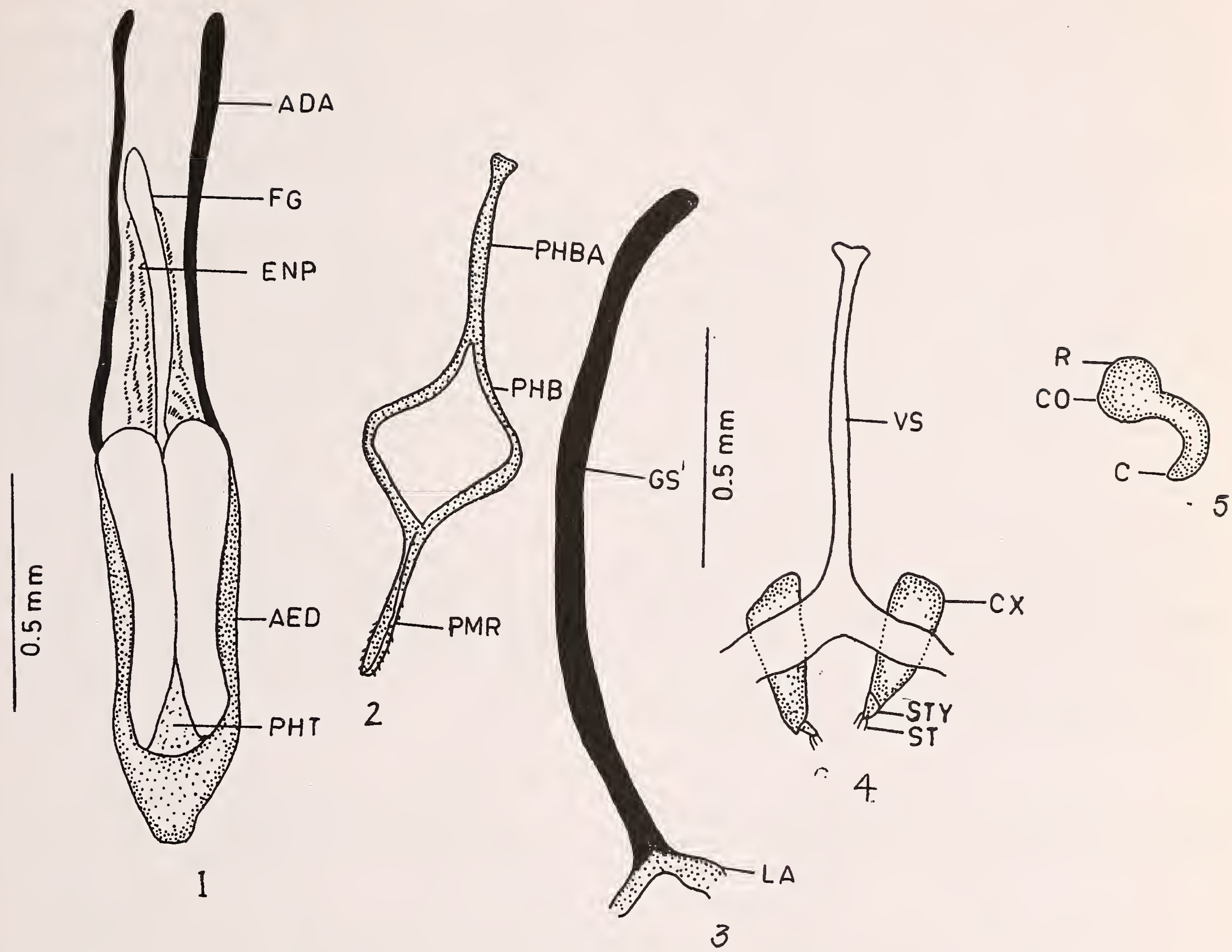

Fig. 1. *Patialus tecomella* sp. nov.
1-3. Male genitalia – 1. Aedeagus, 2. Phallobase; 3. Gastral spiculum, 4. Female genitalia, 5. Spermatheca.

thereafter sparsely covered with long setae. Antennae testaceous, inserted at apical one-third of rostrum; scape as long as funicular segments taken together, gradually clavate; funicle with segment 1 and 2 elongated, segment 2 nearly 1.5 times as long as 1, 3-5 as long as broad, all segments covered with suberect setae; club fusiform, finely and uniformly pubescent.

Prothorax piceous, subconical, broader than long, its sides moderately rounded, with constricted and arcuate anterior margin and bisinuate posterior margin; pronotal surface closely and coarsely punctate, transversely depressed in apical half; vestiture formed of broad median stripe of dark brown scales sparsely variegated with blackish and white linear scales, laterally clothed with closely appressed whitish scales. Scutellum piceous, semicircular and clothed with dark brownish scales.

Elytra piceous, oblong, their dorsal outline convex, running parallel from base to behind middle in male and widening in female, shoulders prominent and roundly rectangular, with apices emarginate; striae narrow, formed by small deep punctures, each studded with a minute recumbent seta; intervals broad, flat, closely and coarsely punctate; vestiture formed of dark brown and light pale recumbent scales, intervals 3 and 5 with small patch of blackish scales.

Legs testaceous, densely covered with dull whitish linear scales; femora laterally compressed, each with a sharp tooth; tibiae slender, each with a fringe of brownish bristles; tarsi densely setose, hind tarsus with joint 1 somewhat longer than 2, 3rd bilobed and spongy beneath; claws long, curved and connate at base and free towards apex.

Thoracic sterna piceous, punctate, each beset with whitish linear recumbent scale; prosternum canaliculate, canal reaching upto middle of mesosternum and closed behind. Abdominal sternites piceous, closely and compactly punctate, uniformly clothed with whitish scales; sternite 1 longer than 2 and 3 taken together.

Male genitalia with aedeagus tubular, lateral walls thick; aedeagal apodemes as long as aedeagus; endophallus beset with rows of spines, flagellum shorter than each aedeagal apodeme. Phallobase ring-shaped; phallobasic apodeme shorter than each aedeagal apodeme, parameres as long as phallobasic apodeme. Gastral spiculum stout with dilated tip; lateral arms short and weakly sclerotized. Female genitalia with coxites tubular; styli 2 times as long as broad with tip beset with setae. Ventral spiculum straight with tip dilated. Spermatheca with cornu curved; ramus and collum indistinct.

Measurements: *Length* Male body : 4.0 - 4.2 mm : rostrum : 1.1-1.2 mm. Female body: 4.2 - 4.5 mm : rostrum : 1.1-1.3 mm

Breadth: Male body : 2.3 - 2.5 mm : rostrum : 0.5 mm. Female body: 2.4 - 2.6 mm : rostrum : 0.5 mm

Holotype: MALE; INDIA; Punjab, Patiala (Punjabi University, Patiala, near Zoology Department); *Tecomella undulata*; 5. V. 1989; H.S. Rose. Paratypes: Males 3, females 4; same data as for holotype; Males 5, females 6; 12-18. IV. 1990; *Tecomella undulata*: Avtar Kaur. Material deposited in Zoology Department, Punjab University, Chandigarh.

ACKNOWLEDGEMENTS

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REFERENCES

KLIMA, A. (1934): Coleopterorum Catalogus, Pars. 138: 61 pp.

MORIMOTO, K. (1962): Key to families, subfamilies, tribes and genera of the super-family Curculionoidea of Japan excluding Scolytidae, Platypodidae and Cossoninae. *J. Fac. Agric. Kyushu Univ., 12* : 21-66.

COPIDOGNATHUS EBLINGI, A NEW SPECIES OF HALACARIDAE (ACARI) FROM ANDAMAN ISLANDS (INDIAN OCEAN)[1]

TAPAS CHATTERJEE[2]

(With eleven text-figures)

A new halacarid species, *Copidognathus eblingi*, collected among the thalli of *Acetabularia* sp. in the intertidal region of Ross Island (Andaman Islands), Bay of Bengal, is described. Its similarities and dissimilarities with the related species of the genus are discussed.

INTRODUCTION

Taxonomic researches on the marine mites of the Indian coast mention a few species names in the classified faunal lists prepared for meiofaunal ecology studies (Rao 1969, 1972, 1980, Rao and Ganapati 1968, Rao and Misra 1983 a,b). The only biosystematic study of Halacaridae from the Indian coast is that of Rao (1970) from the interstitial sands of Visakhapatnam coast. Recently Sarma and Chatterjee (in press) reported the occurrence of *Copidognathus hartwigi* and *Atelopsalis pacifica* for the first time from Indian seas. The present paper describes a new species of the genus *Copidognathus*, *C. eblingi* collected among the thalli of *Acetabularia* sp. in

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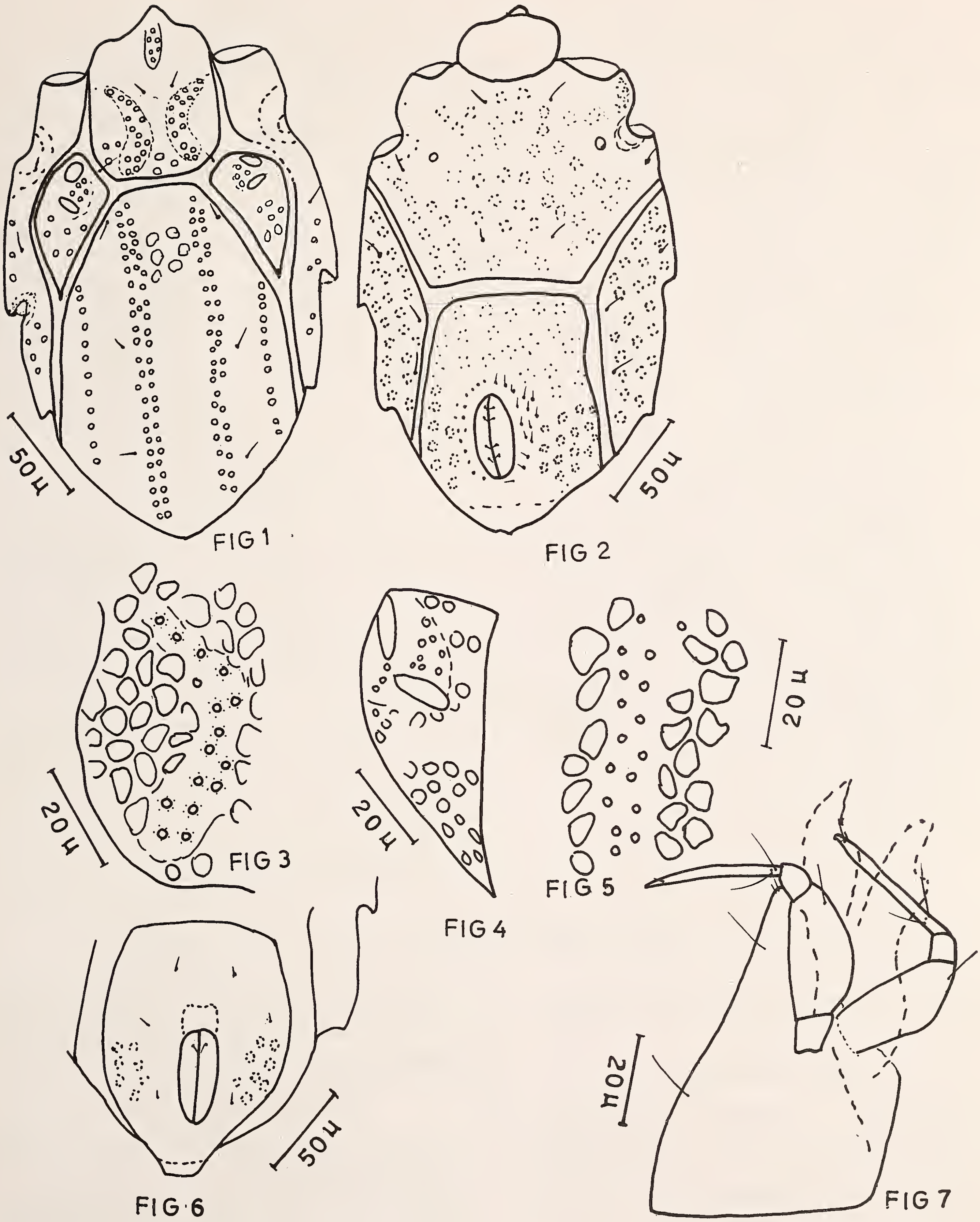
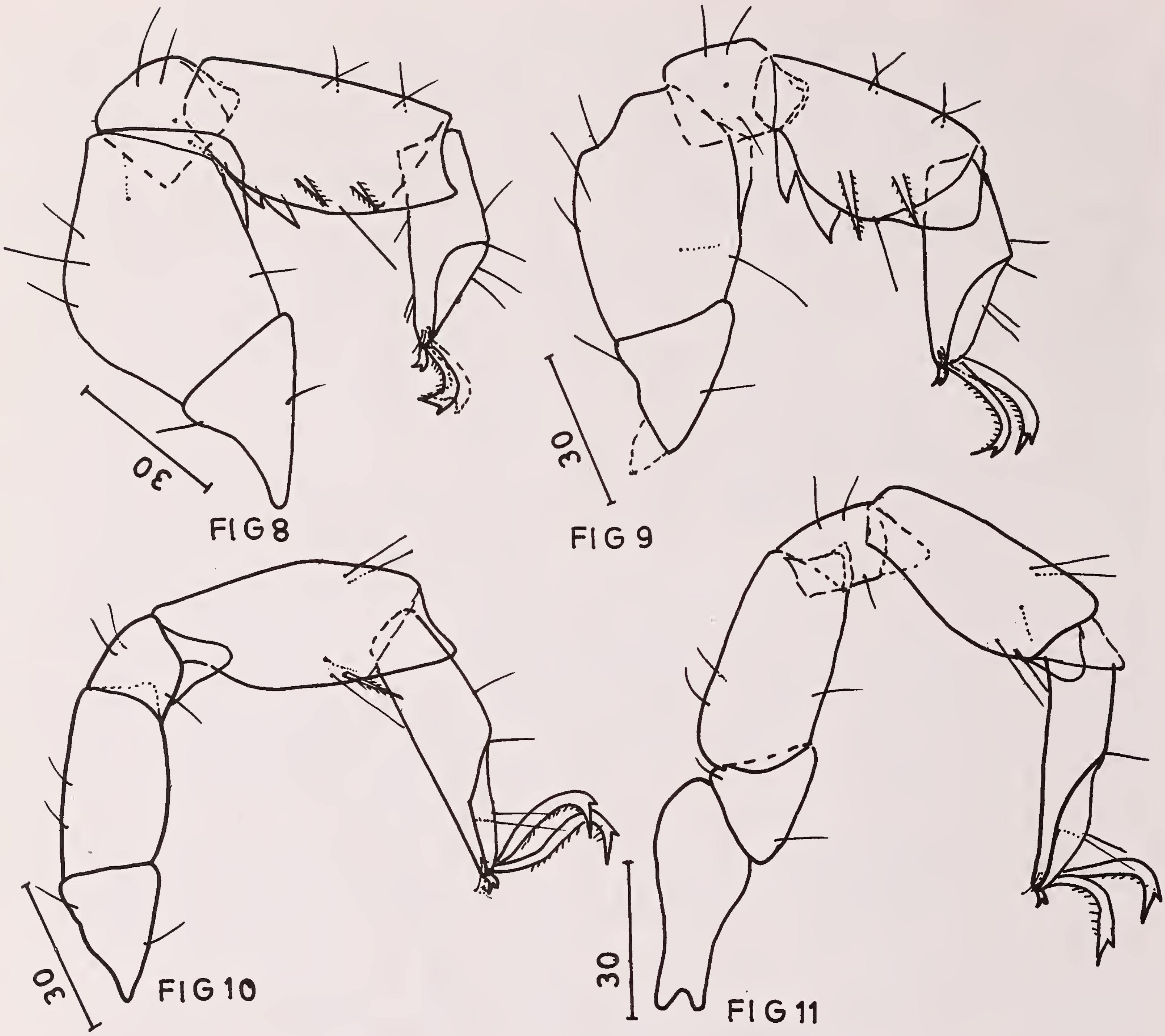


Figs. 1-7. *Copidognathus eblingi* sp. nov.
1. Idiosoma dorsal (male), 2. Idiosoma ventral (male), 3. Magnified view of posterior areola of AD, 4. OC showing corneae, areolae and foveae, 5. Magnified portion of the middle costae of PD, 6. GA of female, 7. Gnathosoma. For abbreviations see text.



Figs. 8-11. *Copidognathus eblingi* sp. nov.
8. Leg I (Basifemur-tarsus), 9. Leg II (Basifemur -tarsus), 10. Leg III (Basifemur-tarsus), 11. Leg IV.

the intertidal region of Ross Is. (Andamans), Bay of Bengal.

Material and Methods

The foreshore algal samples were collected and fixed in 70% alcohol in the field and brought to the laboratory. The halacarids were separated in the laboratory from the algal thalli and preserved in 70% alcohol for specific determination. Later the specimens were treated with lactic acid and rinsed in alcohol in cavity slides. The dissected specimens were mounted in glycerine jelly and sealed.

[3]Named after Prof. (Dr) F.J.G. Ebling, Emeritus Professor of Zoology, University of Sheffield, England, for his pioneering researches on phytal fauna.

Copidognathus eblingi sp. nov.[3]

Classification adopted here is that of Krantz (1978) and Bartsch (1983).

Locality: Several male and female specimens were collected from the algal samples of *Acetabularia* sp. from Ross Is. (Andaman Islands), Bay of Bengal.

Type: Holotype (Male) and other type material are in the author's collection in the Dept. of Life Sc., R.C.E., Bhubaneswar.

Descriptions

Male: The idiosomal length of males ranged between 260 μ and 295 μ. All dorsal plates are separate and coarsely sculptured with both areolae and fovea (Fig. 1). AD (Anterodorsal plate) with three areolae, one located anteriorly and two crescent- shaped posteriorly (Fig. 3). Dorsal seta 1 (ds_1) present anterior to the posterior areolae. Dorsal seta 2 (ds_2) present between AD and ocular plate (OC), just above the anterior margin of OC. Membranous cuticle (mc) between AD and PD (posterodorsal plate) bears parallel striae. OC with two distinct corneae and a few pores between the corneae and fovea on the rest of the OC (Fig. 4). The OC tapers posteriorly, extending up to the insertion of legs III. PD with 4 costae. The two middle costae are two pores wide (Fig. 5) and the paracostae 1-2 pore wide. The ds_3, ds_4, ds_5 (dorsal setae 3,4 and 5 respectively) are on PD between middle and lateral costae placed at anterior, middle and posterior reaches of PD respectively (Fig. 1).

All ventral plates are separate, 1st and 2nd coxal prominences of anterior epimeral plate (AE) bear small areolae on the lateral margins while rest of AE is sculptured with porose panels. AE with 3 pairs of setae. Posterior epimeral plate (PE) bears 3 ventral and one dorsal setae besides two areolae ventrally. Genitoanal plate (GA) with paragenital areolae and panels. 26-38 perigenital setae (PGS) are present around the Genitoanal opening (GO). Four pairs of subgenital setae (SGS) two pairs anteriorly and two pairs posteriorly are present on the GO (Fig. 2).

A pair of proto-, deuto-, trito-, and basirostral setae are present on the gnathosoma. Dorsally the gnathosoma is sculptured with foveae, ventrolaterally with porose panels and ventromedially with canaliculi. Palp 4-segmented. Palpal trochanter and patella without any setae. Palpal tibiotarsus bears 3 basal setae and one singlet distal eupathidia (Fig. 7). The chaetotaxy of legs is as follows:

Trochanter 1, 1, 1, 0 Basifemur 2,2,2,2. Telofemur 5,5,2,3. Patella 4,4,3,3. Tibia 7,7,5,5.

Chaetotaxy of tarsus is discussed in the text.

Trochanter III clavate and devoid of any posterodorsal spine. Telofemorae III bear no ventral setae while IV are with one ventral seta.

Telofemorae, patella and tibiae of legs III and IV have conspicuously elongated distal lamellae (Figs. 10, 11). Telofemorae, patella and tibiae of legs I and II have relatively shorter lamellae than those of III and IV legs.

Tibiae I and II basally bear a pair of denticulous processes ventrally (Figs. 8, 9). Tibiae I and II bear 4 dorsal and 3 ventral setae (two are pectinate and one is smooth, slender and hair-like) respectively.

Tarsus I bears three ventral setae (one filiform seta and two distal eupathidia, three dorsal setae, one solenidion, one profamulus distal to solenidion and 4 parambulacrel setae (PAS) (2 doublets eupathidia). Tarsus II bears 3 dorsal fossary setae, one solenidion, no ventral setae and 4 PAS (two eupathidia doublets). Tarsi III and IV with three dorsal fossary setae and two PAS besides the presence of a proximodorsal seta on tarsus III (Figs. 10, 11).

All legs have well developed claw fossae, two lateral claws and a bidentate median claw. Lateral claws are pectinate ventrally and possess an accessory tooth dorsally.

Female: The length of idiosoma ranges between 270 μ and 304 μ.

The female is similar to the male except for the genitoanal plate. Three perigenital setae are present on each side of the GO. The GO is guarded by a pair of sclerites equipped with a single pair of SGS near the anterior end. Ovipositor short (Fig. 6).

Larvae and nymphs were not found in the samples collected.

Discussion

C. eblingi resembles the members of the key groups 6600 and 7300 which are the extensions of the main key group 5000 (Newell 1984). It is observed that basically the main key group of Newell suffers due to the inadequacies in the scheme as there is no provision to accommodate the widely varying traits of the vastly different and heterogenous species of the extension groups. There are, in all, five species in the extension key group mentioned above. Three of which (namely, *C. curtus* Hall 1912, *C. lunatus* Newell 1984, and *C. semilunatus* Newell 1984) belong to the extension key group 6600 and two species (namely, *C. pectinatus* Newell 1984 and *C. prolixus* Newell 1984) to the extension key group 7300. The two extension key groups mainly differ in that the key group 6600 has

Ds3 on mc and mc quite rugose or slightly rugose while in 7300 Ds3 is on PD and mc bears parallel striae. *C. semilunatus* belonging to the group 6600 bears Ds3 on PD and parallel striae on mc. Thus the distinction envisaged becomes too fragile. By and large, the pliability, plasticity and variability of the traits selected render the key grouping defunct.

The present species differs from the other five species in the presence of a ventral denticulous process at the base of tibiae I and II.

The presence of two crescent-shaped posterior areolae, ds2 on mc, ds3 on PD, 4 costae on PD and tibiae I-II with denticulous process bring the present species nearer to *C. dentatus* Viets 1940. *C. eblingi* sp. nov. differs from *C. dentatus* by the presence of long distal lamellae on telofemorae, patella and tibiae of all legs which are absent in *C. dentatus*. Further, telofemorae III and IV of *C. eblingi* sp. nov. have 0 : 1 ventral setae, where as in *C. dentatus* telofemorae III and IV have 1:1 ventral setae.

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REFERENCES

BARTSCH, I. (1983): vorschlag zur Neugliedorung des systems der Halacaridae (Acari). *Zool. Jb. Syst. 110:* 179-200.

HALL, H.V.M. (1912): Some marine and terrestrial Acarina of Laguna Beach. *1st ann. Rep. Laguna Marine Labor. Pamona coll., Claremont, Calif.* 177-186.

KRANTZ, G.W. (1978): A manual of acarology. 2nd edn. Oregon State Univ. Book store: 1-509.

NEWELL, I.M. (1984): Antarctic Halacaroidea. *Antarct. Res. Ser. 40:* 1-284.

RAO, G.C. (1969): The marine interstitial fauna inhabiting the beach sands of Orissa coast. *J. Zool. Soc. India 21:* 89-104.

RAO, G.C. (1970): On some interstitial fauna in the marine sands of Indian coast. The saltwater mite *Halacarus anomalus* Trouessart in the interstitial sands on Indian coast. *curr. Sci., 39*: 504-507.

RAO, G.C. (1972): On the geographical distribution of interstitial fauna of marine beach sand. *Proc. natn. Inst. Sci. Acad.*, B, *38:* 164-178.

RAO, G.C. (1980): On the zoogeography of the interstitial meiofauna of the Andaman and Nicobar Islands, Indian Ocean. *Rec. Zool. Surv. India, 77:* 153-178.

RAO, G.C. & GANAPATI, P.N. (1968): The interstitial fauna inhabiting the beach sands of Waltair coast. *Proc. natn. Inst. Sci. Acad.*, B, *34:* 82-125.

RAO, G.C. & MISRA, A. (1983a): Meiofauna from Lakshadweep, Indian Ocean. *Cah. Biol. Mar., 24:* 51-68.

RAO, G.C. & MISRA, A. (1983b): Studies on the meiofauna of Sagar Islands. *Proc. Indian Acad. Sci. (Animal Sc.) 92:* 73-85.

SARMA, A.L.N. & CHATTERJEE, T. (in press): Occurrence of *Copidognathus hartwigi* Bartsch 1978 (Halacaridae: Acari) from Indian Ocean. *J. Bombay nat. Hist. Soc.*

SARMA, A.L.N. & CHATTERJEE, T. (in press): Record of *Atelopsalis pacifica* Bartsch 1985 (Halacaridae: Acari) from Eastern Indian Ocean. ibid.

VIETS, K. (1940): Meeresmilben aus der Adria. (Halacaridae und Hydrachnellae, Acari). *Fortsetzung. Arch. Naturgesch., 9: 1-135.*

A NEW SPECIES OF *ERYX* (BOIDAE: SERPENTES: SQUAMATA) FROM SOUTH-WESTERN INDIA[1]

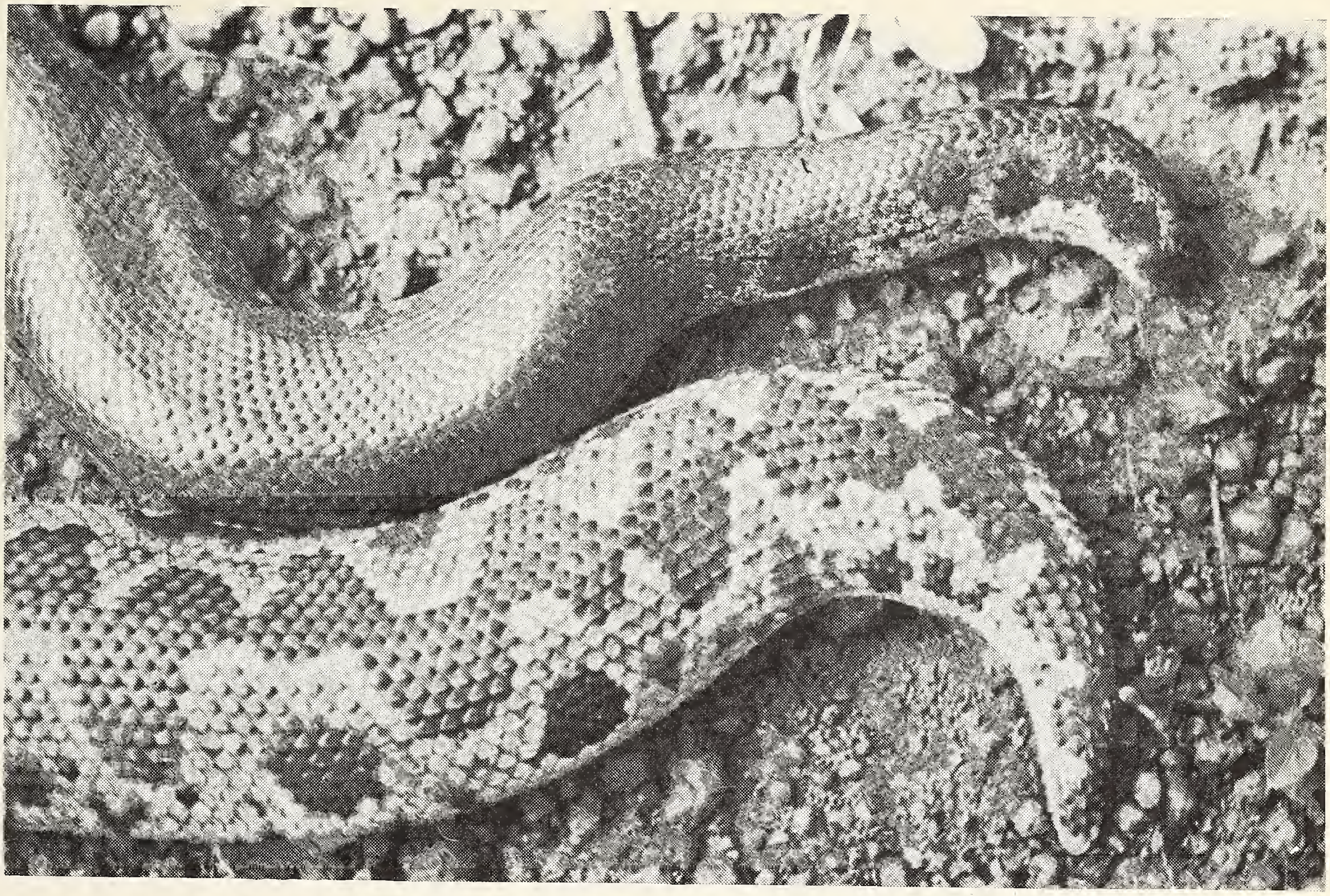
INDRANEIL DAS[2]

(With three text-figures)

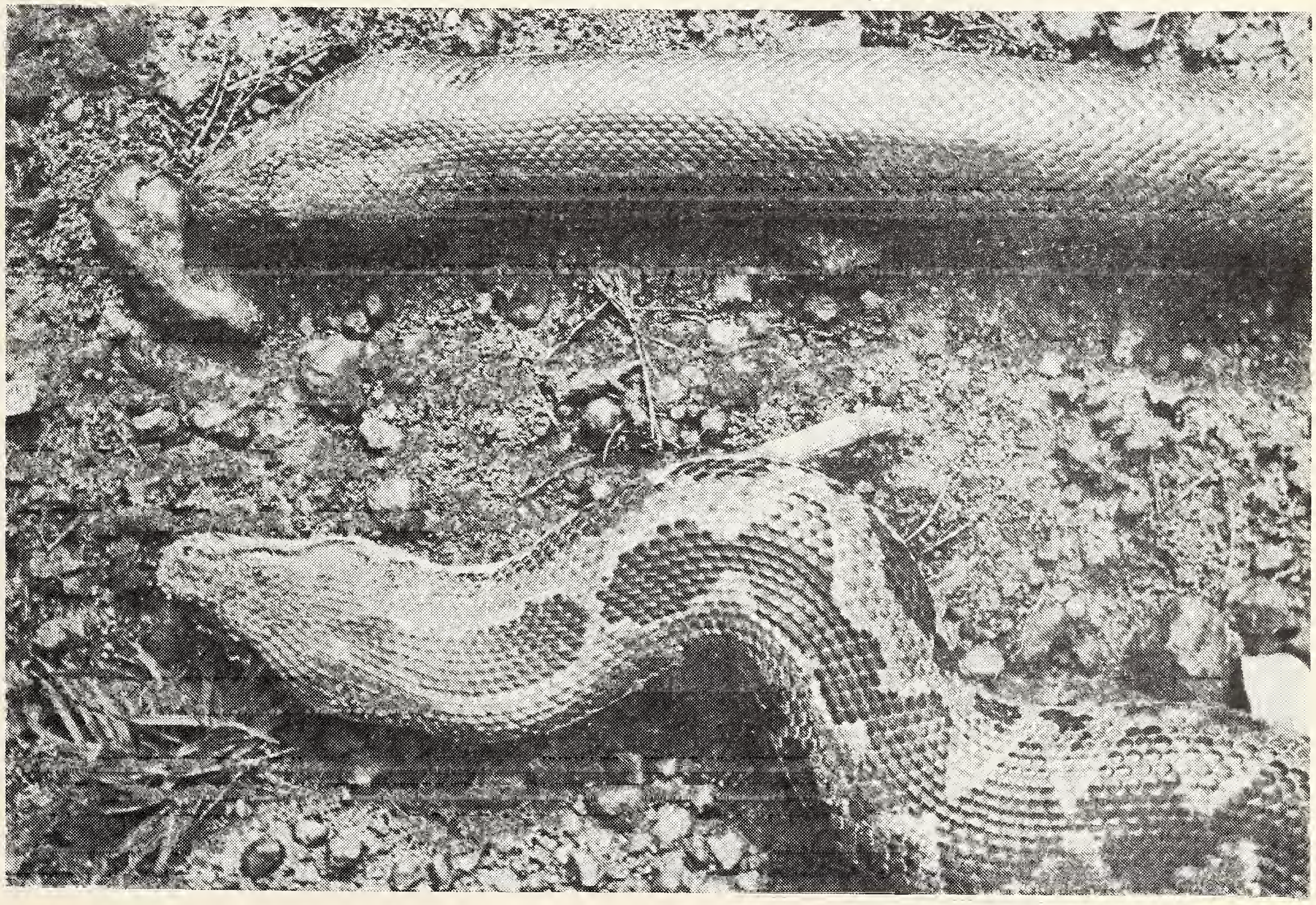
The occurrence of two species of erycine snakes (sand boas), *Eryx conicus* (Schneider, 1801) and *Eryx johnii* (Russell, 1801) in India is documented in the treatises of Gunther (1864), Boulenger (1890, 1893) and Smith (1943), as well as in more recent works on the group. A third taxonomically cryptic erycine from south-western India, whose identity had apparently gone unnoticed, had aroused our suspicion for a long time. Misidentified by earlier workers as *Eryx conicus* or a *Eryx conicus* X *E. johnii* hybrid, morphological observations on a series demonstrates it as a hitherto undescribed species, described here as:

[1]Accepted October 1990.

[2]Madras Crocodile Bank Trust, Vadanemmeli, Perur Post, Mahabalipuram Road, Madras 603 104, Tamil Nadu.



Top: Tail of *Eryx whitakeri* sp. nov. Bottom: Tail of *Eryx conicus*



Top: Head and forebody of *Eryx whitakeri* sp. nov. Bottom: Head and forebody of *Eryx conicus*

Eryx whitakeri sp. nov. (Figs. 1 & 2)

Diagnosis: A medium-sized (at least 79.0 cm total body length and 73.5 cm snout-vent length) erycine, distinguished from other described species of the genus *Eryx* by possessing the following morphological characteristics : smooth scales on dorsal aspect of body; rostral without angular edge; mental groove absent; tail-tip blunt in adults; subcaudals 18-25, ventrals 201-206, midbody scale rows 50-54 and in coloration (dorsally vandyke brown with sepia blotches, edged with chamois, forehead dark vinaceous, ventrally pale horn).

Description: Rostral triangular, just visible from above, smooth, width approximately twice height, without angular edge; eyes small (eye diameter/snout-vent length averaging 0.0063), latero- superior, separated from each other by 8-9 longitudinal rows of scales, 10-11 scales surrounding the eyes; pupil black, vertical, surrounding areas golden yellow; nasals and internasals enlarged; upper labials 13-14, lower labials 17-20; head barely distinct from body somewhat triangular; nostrils slit-like, between two enlarged nasals; mental groove absent; anterior teeth of maxillae and mandibles longer than the posterior ones.

Body cylindrical; scales on the dorsal aspect of head and body small, smooth; tail very short (tail length/snout-vent length averaging 0.072); tip bluntly rounded, especially in the adult; subcaudals single; midbody scales rows 50-54, ventrals 201-206, subcaudals 18-25; anals typically tripartite.

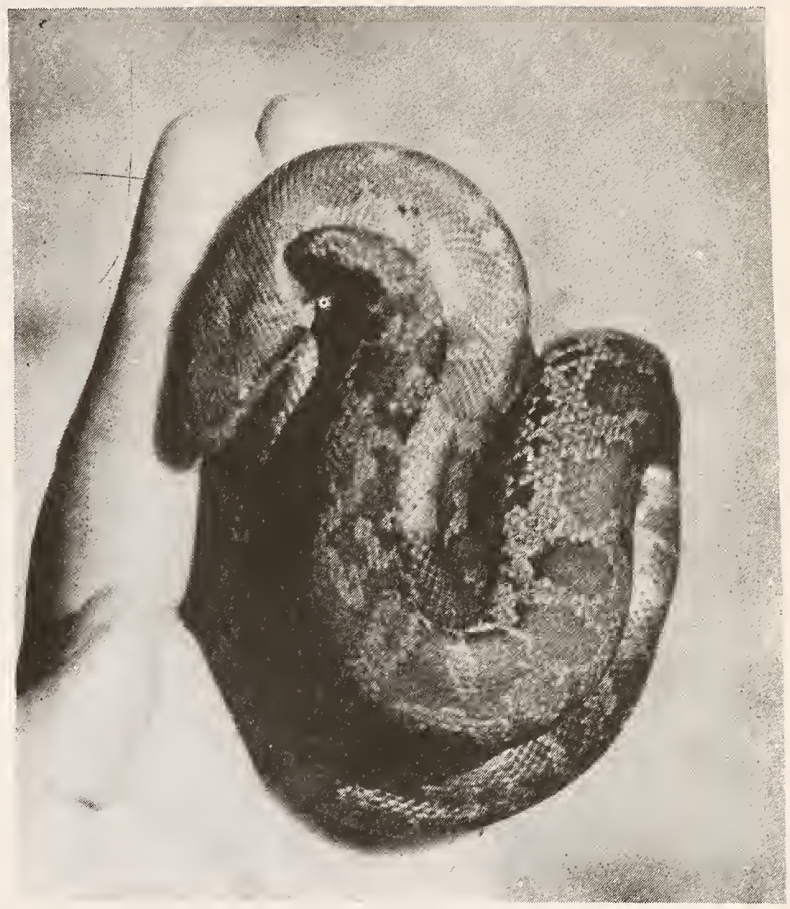


Fig. 1. Holotype of *Eryx whitakeri* sp. nov.

A claw-like spur on each side of the anus in males. Colour (terminology follows Smithe, 1975) dorsally typically vandyke brown, blotched with sepia, darker posteriorly, blotches joined and extend

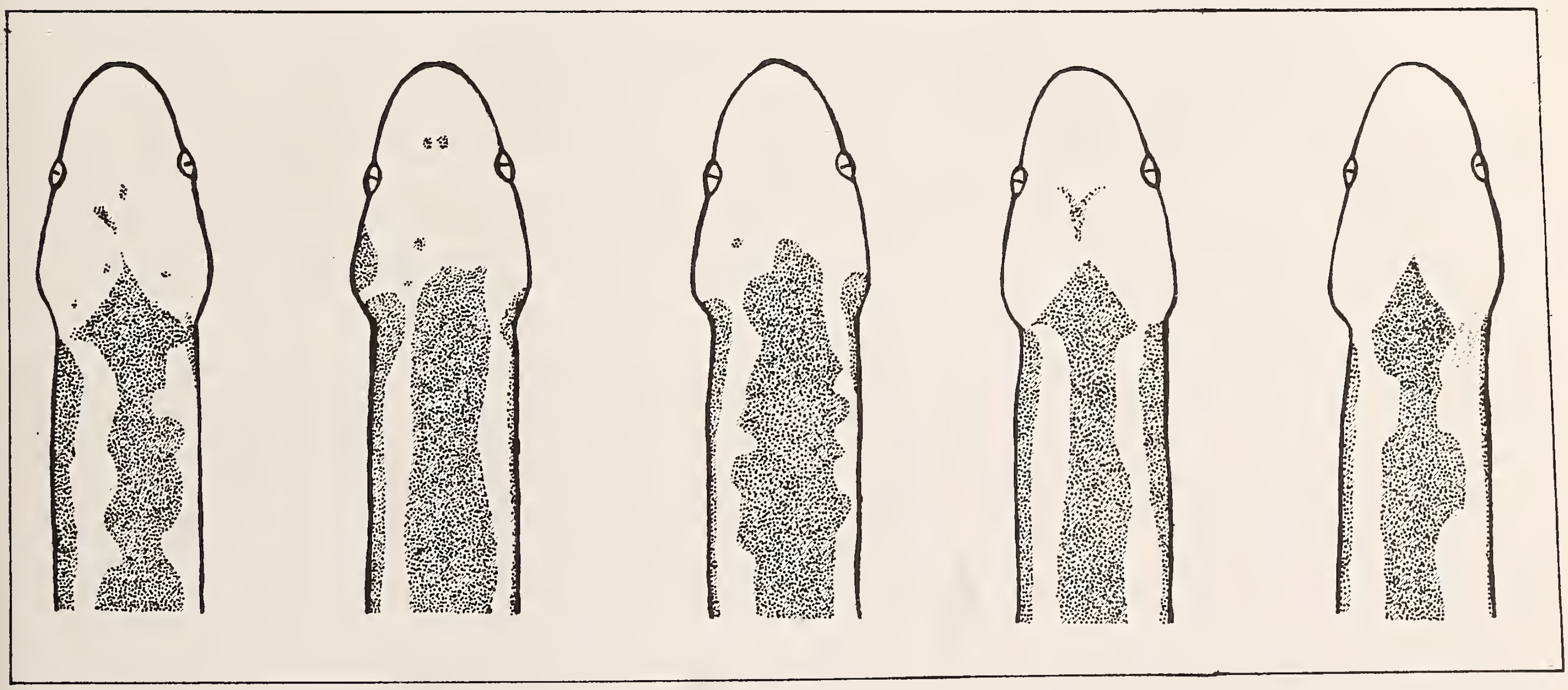


Fig. 2. Variations in head and nape pattern in the types of *Eryx whitakeri* sp. nov. (not to scale)

TABLE 1
MORPHOLOGICAL DATA INCLUDING PHOLIDOSIS OF THE HOLOTYPE OF *Eryx whitakeri* SP. NOV. (ZSI 24810).

Sex	F
Total body length	55.5
Snout-vent length	52.28
Tail length	3.22
Head width	1.53
Body width	2.43
Rostral width	0.44
Rostral height	0.21
Eye diameter	0.22
Interorbital distance	0.71
Weight	104.0
Midbody scale rows	52
Ventral scales	201
subcaudal scales	18
Anal scales	3
Upper labials	14
Lower labials	20
Scales around eye (L & R)	11 and 10
Scales between eye (L & R)	8

Measurements in cm; weight in g.

uninterrupted up to about the middle half of the body, forming a band with irregular edges, another thinner band of the same colour laterally, separated from the streak from the posterior corner of the eyes to the angle of the jaws; forehead closely approaching dark vinaceous; upper and lower lips indistinctly barred with dark sepia; ventrally pale horn.

Holotype: Adult female. ZSI 24810, Mangalore, Karnataka State, India. April, 1990. Coll. Mangalore Snake Park.

Paratypes: Two juvenile females, ZSI 24811 and 24812, Cannanore, Kerala State, India. January, 1990, Coll. M. P. Chandran, Cannanore Snake Park; one juvenile male, ZSI 24813, Felneer Hostel, Mangalore, Karnataka State, India. 21 May, 1990, Coll. Krishna Gopal; One juvenile female, ZSI 22152, Panjim sea beach, 29 km west of Ponda, Goa. 26 September, 1969. Coll. R.C. Sharma and party.

Etymology: The new species has been named after Romulus Whitaker in recognition of his contribution to the herpetology of the Indian subcontinent.

Intraspecific variations: The following variations were found in the five types (see Tables 1 and 2): Tail/snout-vent length proportions 0.062 - 0.079 (X = 0.072 +/- SE 0.0037) the damaged type from Goa excluded; midbody scale rows 50-52 (X = 51.0); ventrals 201-206 (X = 202.6): subcaudals 18-25 (X = 20.4); upper labials 13-14, (X = 13.5); lower labials 17-20 (X = 18.5). The holotype is darker dorsally, with indistinct blotches compared to the paratypes, all of which are juveniles (total body length 22.0-29.1 cm). The variations in the pattern on the forehead and nape of the types have been depicted in Fig. 2.

Comparisons: Closely related to *Eryx conicus*, with which it shares a number of characters, such as a

TABLE 2
MORPHOLOGICAL DATA, INCLUDING PHOLIDOSIS OF THE PARATYPES OF *Eryx whitakeri* SP. NOV. (ZSI 24811, 24812, 24813 AND 22152).

	01	02	03	04
Sex	F	F	M	F
Total body length	22.0	24.2	29.1	29.0
Snout-vent length	20.54	22.49	26.96	26.29
Tail Length	1.46	1.71	2.14	2.71
Head width	0.62	0.68	0.96	1.02
Body width	0.93	0.63	0.98	1.39
Rostral width	0.26	0.27	0.24	0.3
Rostral height	0.14	0.13	0.19	0.17
Eye Diameter	0.16	0.16	0.16	0.22
Interorbital distance	0.49	0.42	0.51	0.56
Spurs	–	–	0.08	–
Midbody scale rows	50	52	50	51
Ventral scales	206	201	202	203
Subcaudal scales	19	18	25	22
Anal scales	3	3	3	2
Upper labials *	14	13	13	
Lower labials	*	20	17	17
Scales around eyes ***	*	11 &10	10 &11	13 & 13
Scales between eyes ***	*	8	9	9

* damaged, ** approximate, *** left and right   measurements in cm.

KEY TO THE SPECIES OF THE GENUS *Eryx*

1. Eyes on upper surface of head, separated by four or five longitudinal series of scales................. *E. jayakari* Boulenger

1'. Eyes latero-superior, separated by five or more longitudinal series of scales 2

2. Rostrals without angular edge 3

2'. Rostral with sharp angular edge 4

3. Tail-tip pointed; dorsal body scales keeled in 40-55 rows; ventrals 161-196 .... *E. conicus* (Schneider)

3'. Tail-tip rounded; dorsal body scales smooth in 50-54 rows; ventrals 201-206 .... *E. whitakeri* sp. nov.

4. Tail-tip pointed 5

4'. Tail-tip blunt 7

5. Tail ends in a curved, claw-like structure; scales between eyes 5 .... *E. muelleri* (Boulenger)

5'. Tail ends in a conical scute; scales between 5-12 6

6. Scales between eyes 9-12; scales round eye 12-15; midbody scale rows 44-59 .... *E. colubrinus* (Linnaeus)

6'. Scales between eyes 5-6; scales round eye 9-11; midbody scale rows 34-40 .... *E. somalicus* Scortecci

7. Midbody scale rows 36 .... *E. elegans* (Gray)

7'. Midbody scale rows more than 36 8

8. Width of interorbital space considerably greater than distance from posterior edge of eye to corner of mouth; front and upper surface of snout slightly convex; 2nd upper labial usually higher than 3rd; ventrals without spots, or with widely separated dark spots .... *E. jaculus* (Linnaeus)

8'. Width of interorbital space equals, less than, or slightly greater than distance from posterior edge of eye to corner of mouth; front and upper surface of snout not convex; 2nd upper labial may be lower or higher than 3rd; ventrals usually with dark confluent spots 9

9. Width of interorbital space considerably less than distance from posterior edge of eye to corner of mouth; eyes directed upward; scales on tail smooth or with scarcely detectable keels; 2nd upper labial usually lower than 3rd .... *E. miliaris* (Pallas)

9'. Width of interorbital space equal, slightly less than, or slightly greater than distance from posterior edge of eyes to corner of mouth; eyes directed laterally; scales on tail with prominent keels at least in adults 10

10. Scales on body smooth, those on tail and on sides near anal region keeled; end of tail much narrower than head; no distinct bands on body or tail, but dark blotches and irregular markings present........................ *E. tataricus* (Lichtenstein)

10'. Scales on body and tail more or less distinctly keeled; tail extremely blunt, often as wide as head; unicoloured or with series of distinctly dark bands on tail, sometimes on body, especially evident posteriorly .... *E. johnii* (Russell)

rostral without angular edge, absence of mental groove and eyes latero-superior.

The new species, however differs from *conicus* in lacking keels on the scales of the dorsal surface of the body, including the forehead; a rounded tail tip; a difference in ventral counts (161-196 in *conicus*, 201-206 in *whitakeri* sp. nov.) and a different colour pattern (raw umber blotches in *conicus*, sepia blotches in *whitakeri* sp. nov.)

Eryx whitakeri sp. nov. differs from the only other previously described erycine species from India, *E. johnii*, in the nature of its rostral, which is without an angular edge (*versus* with a sharp angular edge in *johnii*) absence of a mental groove (present in *johnii*) and a different colour pattern (see below).

A dichotomous identification key to the species of the genus *Eryx* (Daudin, 1803), modified from Boulenger (1893) is given.

Taxonomy and natural history: Khaire and Khaire (1986, 1987) reported on a specimen of the new species, identifiable from scale counts (midbody scale rows 52, ventrals 201, subcaudals 18), description and photographs of the tail from Alibag, Raigad district, Maharashtra, which they mistook for a *Eryx conicus* x *Eryx johnii* hybrid. Collection of the present series from the same general area (the southwestern coast of India) indicates that the taxon is valid. Adiyodi's (1960) anecdotal notes on the biology of an erycine, identified as *Eryx conicus*, are suspected to refer to the new species, the animals being referred to as the 'red earth boa', a red body coloration hitherto not recorded in *E. conicus*, which is raw umber, blotched with yellow ochre or cream on the top of body and with a brownish-olive forehead. The new species, however, has a dark vinaceous (= shade of pink) forehead and base colour of body. However, no mention is made of the locality where the observations took place. The author's address being Cochin, also in the coastal area of Kerala, the possibility that the species referred to is *whitakeri* sp. nov. is likely. Sharma (1976) reported on a collection of reptiles from Goa that included a single example of the new species, identified as *Eryx conicus*. The material (ZSI Reg. 22152) was made one of the paratypes of the new species.

The new species is distributed along the southwestern coast of India, in the states of Kerala, Karnataka, Goa and southern Maharashtra (Fig. 3). One

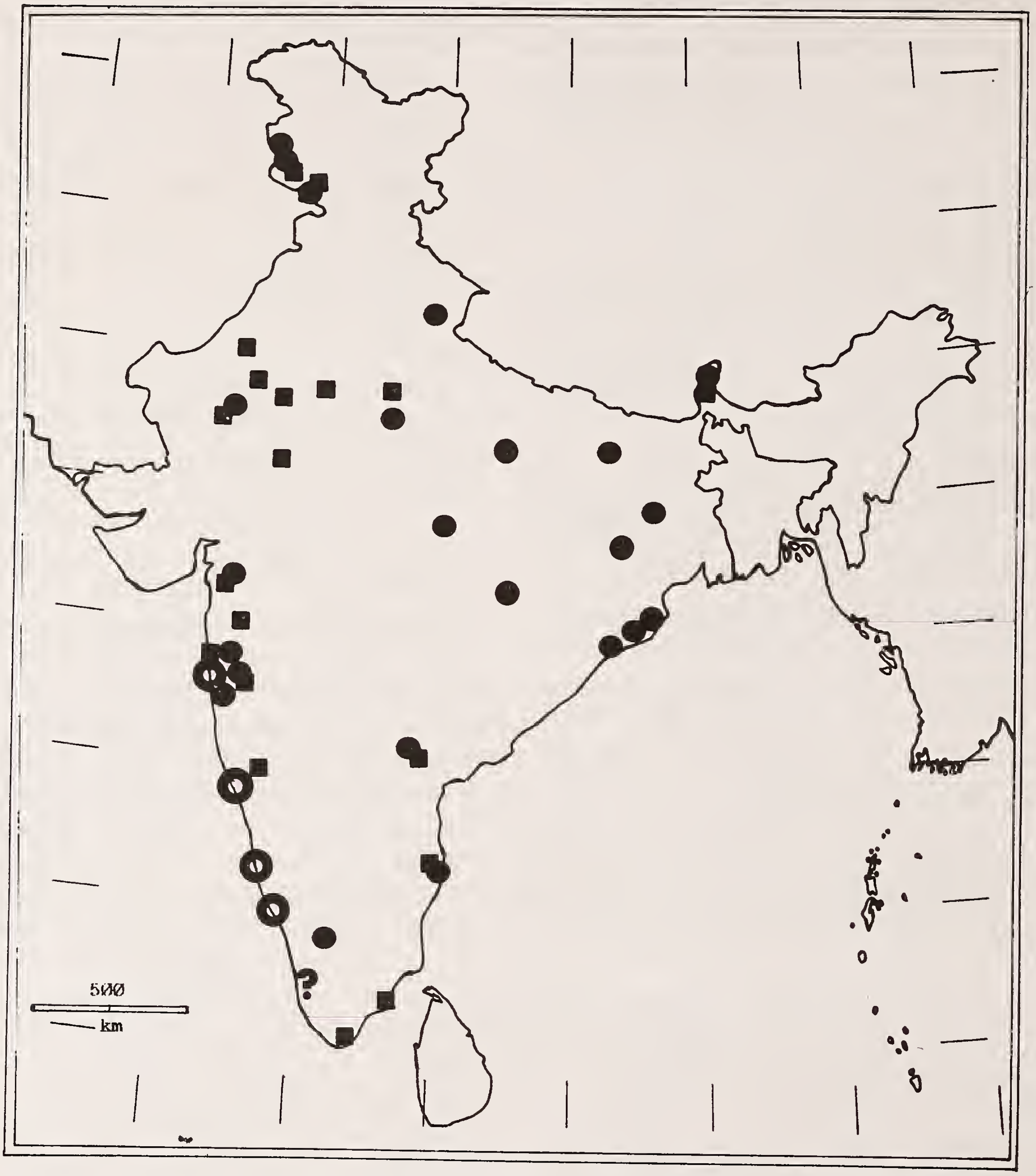


Fig. 3. Distribution of *Eryx whitakeri* sp. nov. (open circles), *Eryx conicus* (closed circles) and *Eryx johnii* (squares) in India based on museum specimen and literature record ? = Record cited in text that is suspected to be the new species.

of the paratypes was collected from scrub country near the sea coast and is abundant in Dakshin Kannada district, Karnataka, where the species is referred to as *irr thale* (= two-headed) in Kannada, on account of the blunt tail-tip that is sometimes mistaken for a second head (Krishna Gopal, *pers. comm.*). Khaire and Khaire (1986) mentioned that their specimen was collected from an area where both *Eryx conicus* and *E. johnii* occur, suggesting that all three species are sympatric.

In captivity, these snakes ate live mice and gerbils, which were seized and swallowed in the manner typical of boids. One juvenile was observed successfully swallowing a young mouse backwards. When alarmed, they hid their heads under the coils of the body or attempted to flatten their bodies onto the substrate. Freshly caught animals showed less aggression than *Eryx conicus,* though when provoked appeared willing to bite. The tip of tail was slightly prehensile.

ACKNOWLEDGEMENTS

The Director, Zoological Survey of India permitted me to examine material at the National Zoological Collection, where the staff of the Reptilia Section, D.P. Sanyal, Scientist D, B. Datta Gupta and N.C. Gayen, Sernior Zoological Assistants, provided assistance and facilities.

The Mangalore Snake Park, through B.K. Sharath provided the holotype, one was collected by Krishna Gopal and the rest obtained by M.P. Chandran of the Cannanore Snake Park. Manuscript preparation was supported by the Madras Crocodile Bank Trust, and I thank Rom Whitaker, Harry Andrews and Shekar Dattatri for their help. Donald G. Broadley and Garth Underwood read an earlier draft of the manuscript and provided useful comments and information. Don Broadley's help in preparing the key to the genus *Eryx* is gratefully acknowledged.

REFERENCES

ADIYODI, K.G. (1960): Observations on the red earth boa or Russell's earth-snake [*Eryx conicus* (Schneider)]. *J. Bombay nat. Hist. Soc. 57 (3):* 671-672.

BOULENGER, G.A. (1890): The fauna of British India, including Ceylon and Burma. Reptilia and Batrachia. Taylor and Francis, London. 541 pp.

BOULENGER, G.A. (1893): Catalogue of the snakes in the British Museum (Natural History). Vol. I. British Museum (Natural History), London. xiii + 448 pp.

GUNTHER, A.C.L. (1864): The reptiles of British India. Hardwicke, London. xxvii + 452 pp.

KHAIRE, A. & KHAIRE, N. (1986): A report on the occurrence of hybrid between *Eryx conicus* (Schneider) and *Eryx johnii* (Russell). *The Snake 18:* 114-117.

KHAIRE, A. & KHAIRE, N. (1987): A report on the occurrence of hybrid between *Eryx conicus (Schneider) and Eryx johnii* (Russell). *Hamadryad 12 (2): 7.*

SHARMA, R.C. (1976): Records of the reptiles of Goa. *Rec. Zool. Surv. India 71:* 149-167.

SMITH, M.A. (1943): The fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese subregion. Reptilia and Amphibia. Vol. 3. Serpentes. Taylor and Francis, London. xii + 583 pp.

SMITHE, F.B. (1975): Naturalist's color guide. American Museum of Natural History, New York.

CINNAMOMUM CHEMUNGIANUM (LAURACEAE)—A NEW SPECIES FROM KERALA, SOUTHERN INDIA[1]

M. MOHAN AND A.N. HENRY[2]

(With a text-figure)

"Chemungi" (Chemungimottai) is an isolated peak in the southern Western Ghats in Thiruvananthapuram (Trivandrum) District of Kerala. This peak is situated on the approach way from Bonecord in Kerala to Kannikatti in Tamil Nadu. A botanically rich area, Chemungi is the type locality of many taxa collected by Bourdillon and others, and described by subsequent authors like Gamble and Fischer. During an intensive plant exploration work in this area for the preparation of the 'Flora of Thiruvananthapuram Dt." one of us (MM) collected an interesting specimen of the genus *Cinnamomum* Schaeff. This specimen was first matched with *C. travancoricum* Gamble (type locality - Chemungi); but on a critical examination it was found to be distinct and is hence described as a new species.

Cinnamomum chemungianum sp. nov.

Planta inter *Cinnamomum filipedicellatum* Kosterm. et *C. travancoricum* Gamble quasi intermedia. A *C. filipedicellatum* Kosterm. foliis parvioribus, ovatis, ad basim rotundis, paginis inferis minute pilosis; paniculis pedunculis et pedicellis brevioribus; floribus magnioribus et a *C. travancoricum* Gamble foliis brevioribus, microscopicue pilosis (vice dense pilosis in *C. travancoricum*), ovatis, ad basim rotundis; paniculis glabris (vice racemes dense pubescentis in *C. travancoricum*); perianthiis lobis brevioribus differt.

Shrubs or small trees, 3-4 m tall; branches slender, terete; terminal buds small, minutely sericeous. Leaves 3-7 by 2-4 cm, thinly coriaceous,

[1]Accepted March 1991.

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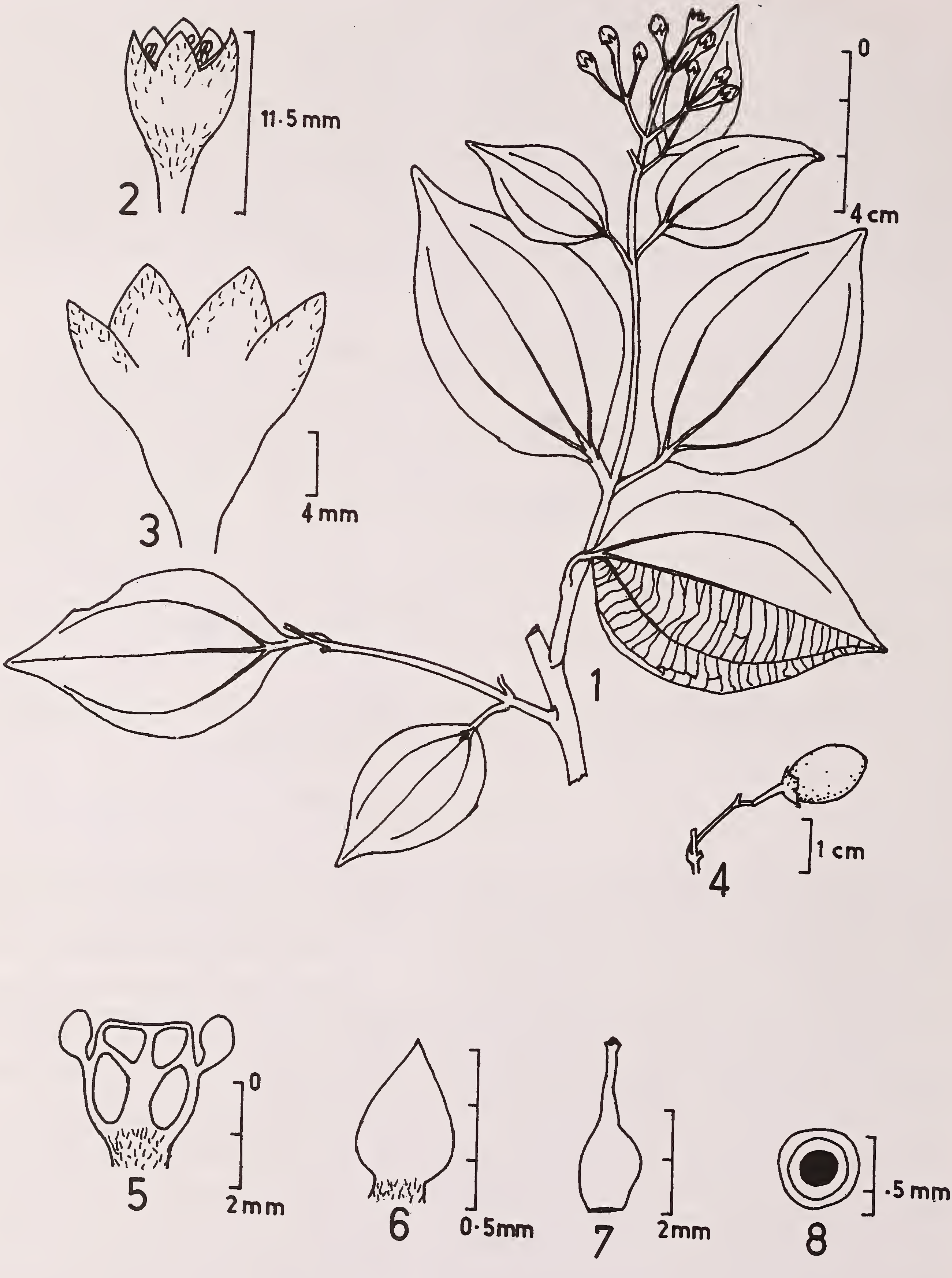


Fig. 1. *Cinnamomum chemungianum* sp. nov.
1. Twig, 2. Flower, 3. Perianth split open (part) 4. Fruit, 5. Stamen, 6. Staminode, 7. Pistil, 8. . Ovary (c.s.)

TABLE 1
DEFFERENTIATION BETWEEN 3 SPECIES OF *Cinnamomum*

Characters	*C. filipedicellatum*	*C. travancoricum*	*C. chemungianum*
Leaves:			
size	4-5.5 by 8-13 cm	2-6 by 3.5-8 cm	3-7 by 2-4 cm
shape	linear-lanceolate	elliptic to subovate	ovate
apex	obscurely acuminate	obscurely acuminate	caudate acuminate
base	acute	acute	rounded
vestiture	glabrous (microscopi cally hairy when young)	densely appressed pilose beneath	sparsely appressed pilose beneath
Inflorescence:			
size	panicles up to 10 cm long	racemes up to 3 cm long	panicles up to 4 cm long
vestiture	glabrous (minutely puberulous at nodes)	appressed pubescent	glabrous
peduncle	up to 3 cm long	up to 1 cm long	up to 2 cm long
pedicel	5-15 mm long	1-3 mm long	4-6 mm long
Flowers:			
size	2-2.5 mm long	2.5-3 mm long	1-1.2 cm long
perianth lobes	up to 2 mm long	up to 4 mm long	up to 1.5 mm long

smooth and glossy above, sparsely appressed pilose beneath when young, ovate, caudate acuminate at apex with 1-2 cm long acumen, rounded at base; lateral nerves reaching 3/4 of the length; petioles 0.6-1 cm long, glabrous, concave above. Inflorescence a much reduced panicle, up to 4 cm long, glabrous, axillary or pseudoterminal; peduncles 1.5-2 cm long, glabrous; pedicels 4-6 mm long. Flowers 1-1.2 cm long. Perianth lobes 6 in two whorls of 3 each, *c.* 1.5 mm long, appressed pilose, red, ovate, acute at apex; tube *c.* 3 mm long, pilose. Stamens many in 3 rows, *c.* 1.5 mm long; anthers truncate, 4-loculed, glandular; filaments villous; staminodes *c.* 0.5 mm long, ovate, acute. Ovary *c.* 2 by 1.5 mm, subglobular, 1-ovuled; styles 1 mm long; stigmas faintly 3-lobed. Berries c. 1.4 by 1 cm, ellipsoid.

Holotype M. Mohanan 61830 (CAL) and isotypes M. Mohanan 61830 (MH Acc. No. 136396-97) were collected from Chemungi, Thiruvananthapuram dt., Kerala (alt. *c.* 1450 m) on 19 May 1979.

This rare plant grows in the dense forests along the slopes of Chemungi.

Flowering and fruiting: December-March.

This species is closer to *C. filipedicellatum* Kosterm. but differs from it by the smaller ovate leaves rounded at base and minutely pilose beneath, shorter panicles, peduncles and pedicels, and larger flowers. It is also nearer to *C. travancoricum* Gamble but differs by the smaller, microscopically pilose (densely pubescent in *C. travancoricum*), ovate leaves with rounded base; glabrous panicles (densely pubescent racemes in *C. travancoricum*); and shorter perianth lobes. The differentiation among these three species is shown in Table 1.

We are thankful to Dr V.J. Nair, Scientist SD, Botanical Survey of India, Coimbatore for rendering the Latin translation.

A NEW SPECIES OF *THRAULUS* (EPHEMEROPTERA: LEPTOPHLEBIIDAE: ATOLOPHLEBIINAE) FROM NILGIRIS, SOUTH INDIA[1]

A.K. ARUMUGA SOMAN[2]

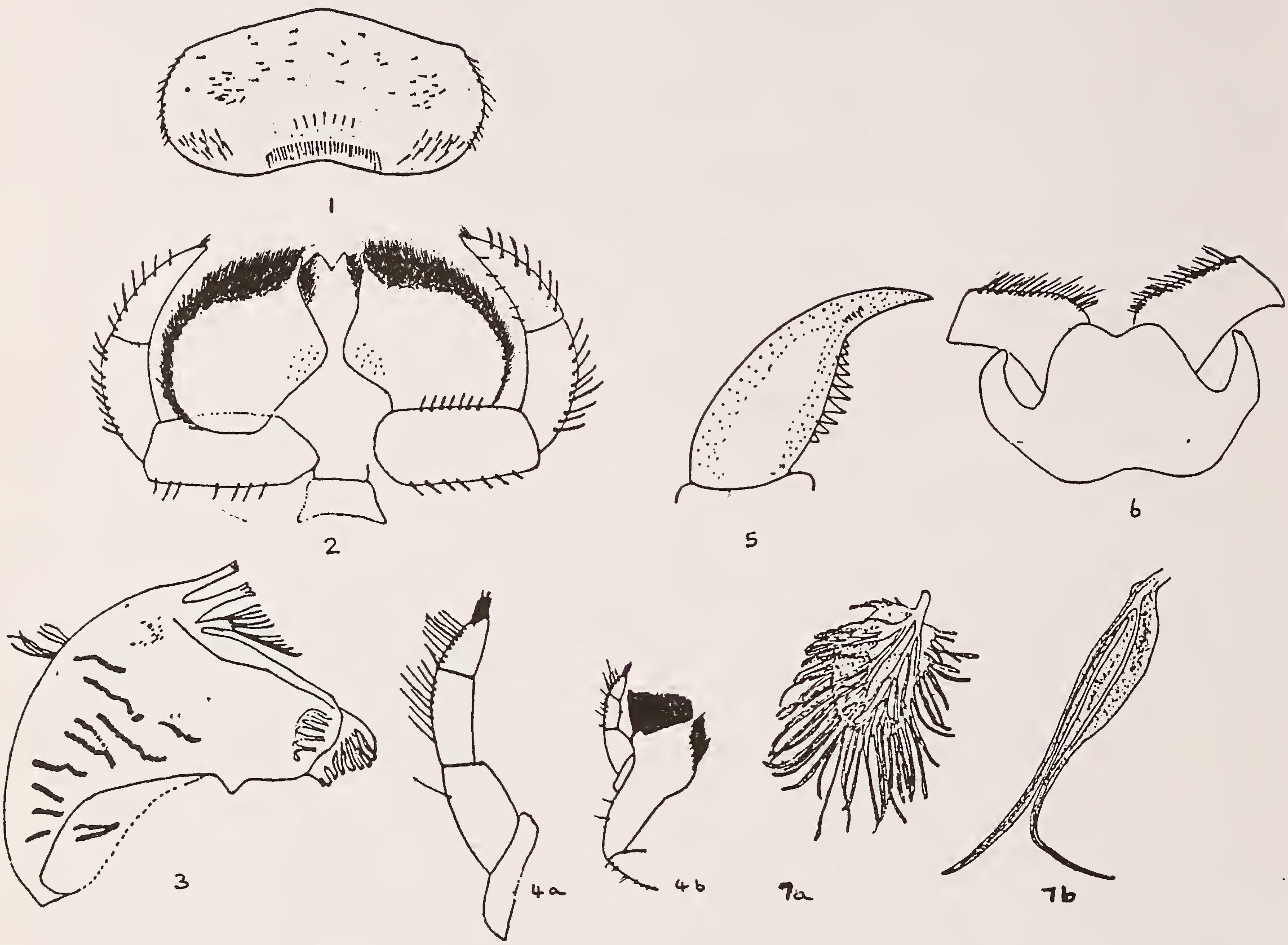
(With seven text-figures)

Thraulus mudumalaiensis, sp. nov. is described from the collections made in Nilgiris, south India. Descriptions are provided for a female nymph.

[1]Accepted February 1989.

[2]Bhavan's Gandhi Vidyashram and Madras Science Foundation, P.O. Box No. 9, Golf Club Road, Kodai kanal 624 103, Tamil Nadu.

Eaton in 1881 established the genus *Thraulus* for the species *Thraulus bellus*, followed by *T. turbinatus* (Ulmer 1909), *T. semicastaneous* (Gillies



Figs. 1-7. *Thraulus mudumalaiensis* sp. nov. (female)
1. Labrum, 2. Labium (dorsal and ventral), 3. Mandible, 4 a. Max. Palpi (magnified), 4 b. Maxilla, 5. Claw of foreleg, 6. Hyphopharynx, 7 a. 4th gill, 7 b. 1st gill.

1951), *T. faciatus* (Kimmins 1956), *T. torrentis* (Gillies 1964), *T. bishobi* Peters and Tsui 1972, *T. demoulini* Peters and Tsui 1972, *T. mariae* Peters and Tsui 1972, *T. hsui* Peters and Tsui, 1972, *T. gopalani* Grant and Sivaramakrishnan 1985 and now *T. mudumalaiensis* sp. nov. which has been from Nilgiris, South India.

Thraulus mudumalaiensis sp. nov. (Figs. 1-7)

Female nymph (in alcohol). Body length 6.3 mm, head width 1.3 mm.

Head (Figs. 1-4 and 6): Prognathus, pale, washed evenly between eyes, ocelli and antennal sockets. Eyes dark purplish, nearly black, subtriangulate, separated from one another by 4.3 times the width of an eye. Antennae pale with scape, pedicle, flagellum. Mouth parts (Figs. 1-4, 6): Labrum (Fig. 1) with smoothly curved emargination, without denticles, width 2.0 times the length. Two rows of dorsal setae not parallel; inner row short and more or less straight and outer row curved outwards and an irregular intermittent row of setae seen in between them

ventrally. Group of setae on either of anteriolateral side of labrum. Mandibles (Fig. 3) lateral margin arculate, smoothly rounded, with a short row of hairs about 7 in number in between the distance of 0.6 to 0.78 (Ca.)[3] from basal. Prostheeal tuft with 14 stiff hairs on left mandible, 9 in right. Incisors unserrated, end in trident structure. Hyphopharynx (Fig. 6) Lingua, snow-white in color with well developed lateral processes, apex of submedian lobe notched, super lingua brownish yellow with a row of hairs along the anterior margin. Maxillae (Fig. 4a, 4b) galea and lacinia narrow at apex. Segmental lengths of 1st, 2nd and 3rd are 17, 17 and 12.5 (Ca) respectively. Segment 2 of maxi. palpi is almost equal to the length of segment 1 and segment 3 of the max. Palpi is 0.74 the length of segment 2. Widths of the apical and subapical rows are 0.88 and 0.65 respectively to the width of galealacinia. Labium (Fig. 2): mesal region of the paraglossa and inner lateral side of the glossa snow-white in colour. Anterior side of the glassa and paraglassa light yellowish brown. Segments of labial palpi 1st, 2nd and 3rd are 28,20,23 (Ca.) respectively. Segment 2 of the labial palpi 0.7 the length of segment 1, and segment 3 of the palpi a little longer than segment 2.

Thorax: Pronotum, anterior margin curved. Pronotum, mesonotum, metanotum, intercoxel area, sterna, pleura are generally washed with testaceous. Basal area of forewing yellow with a little tinge of brown. Coastal area of forewings hyaline. Middle leg coxae, with brown shading, trochanter with a few spines. Inner side of the femora not angulate, tibia with prominent bristles on outer side and improminent spines throughout the length of inner side, which are subequal in length. Claw of foreleg (Fig. 5) tip dull reddish brown and mesal region greenish yellow in colour with 10 basal denticles increasing medially and decreasing apically and subapical row with 5 minute denticles.

Abdomen: Brownish yellow in colour, 1-6 of the terga with pale mesal line. 10th segment light ochraceous, 9th tergite's lateral side with dull brown band. Lateral sides of terga and spiracular area pale in colour, Posterolateral projections in 8th and 9th segments light ochraceous and acuminate. Gills (Fig. 7a, b) yellow with little tinge of brown, veins clear, 1-7 dismiler, gill 1 dorsal lanceolate and ventral slender. 2-7 gill's (Fig. 7a) dorsal elliptical and ventral oval shaped with entire margin fringed, length of the fimbriae increased apically. Caudal filaments, terminal slightly longer than the cerci.

Thraulus mudumalaiensis can be distinguished from all other known described species by the following combination of characters in the nymph 1) claws (Fig. 5) with 5 minute denticles in apical set and 10 larger denticles in basal row in which the size increases medially, then decreases apically. 2) labrum (Fig. 1) without denticles in the emargination and has 2 rows of setae on dorsal side and an irregular intermittent setae ventrally in between the 2 dorsal rows, a cluster of setae of either of the anterolateral side of its venter. 3) coastal area of forewing pads hyaline, without longitudinal brown streak. 4) mandibles (Fig. 3) with lateral sides smoothly rounded with some setae on mid region. 5) maxillary palp (Fig. 4a) has 2nd segment almost equal to the length of segment 1, segment 3, 0.74 the length of segment 2. 6) labial segment (Fig. 2.) segment 2 is 0.7 the length of segment 1 and segment 3 a little longer than segment 2.

Thraulus mudumalaiensis is closely allied to *Thraulus bishopi* in the following characters. Gill 1-7 dissimilar, gill 1 (Fig. 7b) dorsal lanceolate and ventral slender. Gills 2-7 (Fig. 7a) dorsal ovate with entire margin fringed and absence of macula on 2-9 sterna. Setae on middle tibia subequal in length. Abdominal terga 8-9 with posterolateral spines, claws with apical — most denticles of subapical row not disproportionately large.

Distribution: *Thraulus mudumalaiensis* is known only from Nilgiris, Tamil Nadu.

Biology: It was found on a small sized slightly algal coated stone which was crawling with nymphs of *Chorotrepes* sp., *Baetis* sp. Heptageneidae and Caenidae of Ephemeroptera, and nymphs of Trichoptera and Plecoptera at a depth of 15 cm in the middle of a slow moving clear stream.

Etymology: This species is named after the place where it was collected first.

Type data: Female nymph, with abdomen and part of thorax in alcohol and mouth parts, legs, gills in slides with following label. Holotype: INDIA: Nilgiris, Mudumalai, 950 m, 2 IV 88, with slide numbers A.K.A 1-15, Reg. No. I.E.1a-p., which have been deposited in the Zoological Survey of India, Madras, Tamil Nadu.

[3]Ca. = Calibration

References

Grillies, M.T. (1951): Further notes on Ephemeroptera from India and south east Asia. *Proc. R. ent. Soc. London (B) 20:* 121-130.

Kimmins, D.E. (1956): New species of Ephemeroptera from Uganda. *Bull. Brit. Mus. (Nat. Hist.), London. Ent. 4:* 69-87.

Peters, W.L. & Tsui, P.T.P. (1972): New species of *Thraulus* from Asia (Leptophlebidae: Ephemeroptera). *Oriental insects 6(1):* 1-17.

Ulmer, G. (1909): Ephemeriden von. Madagaskar und den comoren. In: Reise in Ostafrica v. A. Voeltkow Bd. 2. Stuttgart (E. Schweizerban): 365-368.

REVIEWS

THE ASIAN ELEPHANT: ECOLOGY AND MANAGEMENT By R. Sukumar. Cambridge University Press, 1989. Price £ 40.

At a time when international concern is focused heavily on the plight of the African elephant *Loxodonta africana* whose numbers have declined over the decades to about 600,000, it is disturbing to know that there are only about 34,000 to 56,000 Asian elephants *Elephas maximus* left throughout Asia. Much of the decline in the number of Asian elephant has been due to the loss of habitat through competition with man.

Dr Sukumar's book has synthesised almost a decade's observations and research on the Asian elephant carried out in southern India. It is the only serious book of this nature currently available as far as the Asian elephant is concerned. As such it becomes an invaluable source book for wildlife managers and ecologists involved with the conservation and management of the elephant in Asia. Given its easy style, it can also be read by anyone wishing to learn more about the dynamics of elephant populations.

The book reviews the status of the Asian elephant in the Indian subcontinent, continental southeast Asia and in such islands in Asia as Sri Lanka, Sumatra and Borneo. The book is largely based on the author's field studies carried out in an area of 1,130 sq. km spread over the Chamarajanagar, Kollegal and Satyamangalam Forest Divisions in southern India. In view of the fact that this study area also included a 70 sq. km enclave of cultivated land, the book addresses such key conservation and management issues as crop raiding and manslaughter by elephants, and poaching and habitat manipulation by man. The book discusses not only the causes of crop raiding but more importantly, it provides a number of practical methods to mitigate such attacks.

One of the most interesting chapters in the book is about the dynamics of elephant populations in which Dr Sukumar assesses the influence of habitat conditions on the performance of the elephant populations. That the age at sexual maturity is very plastic in elephants and can be deferred in unfavourable situations has been documented by Dr Richard Laws in the case of the African elephant. In Asia, it appears that the mean age at first calving may be as late as 18-20 years. Bull elephants may not be able to mate until they are older than 20 or 25 years owing to prevailing social hierarchy. Mean calving interval of 4.7 years recorded in the field compares favourably with the most productive African elephant populations.

Dr Sukumar's book must be regarded as an invaluable asset to any wildlife manager involved with the management of elephants. It is particularly useful in understanding the more common problems of why elephants raid crops, and how elephant populations can be vulnerable to demographic, environmental and genetic stochasticity once their size becomes too small. The book also underlines the success in breeding elephants in semi-natural conditions. In Tamil Nadu alone, between 1950 and 1983, about 74 calves were born to 37 captive adult cow elephants. Such a success was achieved mainly because the animals were kept in larger groups (more than 10 animals) and let out for feeding at night in the forest, where wild bull elephants could mate with the cows. Here perhaps is a pointer to those zoo authorities who wish to breed endangered species in captivity. Large mammals are more likely to breed in natural or semi-natural conditions than in the confines of the zoos alone.

The book is illustrated with clear black and white photographs of elephants and their habitats in India. If there is one factor that is disagreeable about this book, then it must surely be its prohibitively high cost at 40 pounds sterling! At such a price, most of the wildlife managers and scientists in the third world would find it beyond their reach. This can be overcome by producing a cheaper paperback edition which would be of enormous use to everyone interested in this conspicuous and endangered species of large mammals.

CHARLES SANTIAPILLAI

ETHNOBOTANY (Journal of Society of Ethnobotanists). Edited by Dr S.K. Jain (Chief Editor), Dr R.R. Rao, Dr B.N. Mehrotra, Dr S.L. Kapoor, Dr Roma Mitra, Dr S.K. Manilal, Dr J.J. Maheshwari, Dr N.C. Shah and Dr Ved Prakash. Vol. 1 (Nos. 1 & 2), pp. 1-116 (2 cm x 18 cm). New Delhi, 1989. Deep Publications. Annual subscription: Rs. 200 or US $ 50.

This premier issue of the journal representing the first volume (incorporating Nos. 1 & 2) for the year 1989 comprises 116 printed pages with a dozen of articles on various topics on Ethnobotany.

In the opening article, Dr S.K. Jain, the chief editor of the journal, has given guidelines of the topics which will be acceptable for publication in the journal, and a note on justification for the need of a separate Ethnobotanical journal.

In addition to the editorial board, the journal has a

comprehensive advisory panel comprising of 23 subject experts from various countries like U.S.A., Canada, Japan, U.K., Hungary, Tanzania, Spain and New Zealand. Surprisingly, in spite of a fairly large number of office bearers of the society and a good editorial board, it appears that the publication of the journal will be managed by private publishers - M/s Deep Publications.

Two articles in the issue are particularly noteworthy:
1. A case history: Identification of Yoco, a stimulant of the Northwesternmost Amazonia, by Richard Evans Schultes.
2. The traditional Geographical range and Ethnobotanical diversity of Indian Valeriana, by Ved Prakash, B.S. Aswal and B.N. Mehrotra.

During the last decade, a number of botanical societies have come out with various types of journals, among which the Journal of Ethnobotany is unique as it tries to project to the public the authentic information about various types of plants of different countries.

It is interesting to note that in spite of the modern scientific developments, a number of traditional practices are still followed in various countries; this can be visualised while going through the various articles presented in the journal.

Perhaps the journal may require much more interdisciplinary data in order to serve the growing needs of the young, enthusiastic scientists in India today.

DR (MRS) S M ALMEIDA

WORLD PLANT CONSERVATION BIBLIOGRAPHY, 1990. Compiled by The World Conservation Monitoring Centre and Royal Botanic Gardens, Kew. pp. i-xv +1-645 (24.5 x 15.5 cm). Published by Royal Botanic Gardens, Kew. Price: £ 15 (extra for postage –15% for UK and 17.5% for overseas by surface mail).

The volume includes over 10,000 citations to literature about plant conservation published during the last decade. The scope of this book ranges from highly specific papers on individual threatened plant species to more general papers on conservation strategy, policy and law. It includes literature at all levels – local, national and international.

The publishers make no claims about the comprehensiveness of this volume but hope that it will prove useful to those who need access to literature.

A vast amount of information on plant conservation is scattered in numerous journals and periodicals, some of which are very little known outside their own regions. Access to this information in a single volume, therefore, is a great service to the individuals or small organisations which have no direct links to the larger scientific libraries.

Entries in the book begin with general references followed by regional references and regions arranged alphabetically, and then finally according to alphabetical order of countries. Within the countries there are subdivisions of states, union territories or geographically separated islands.

India is covered by 387 entries, occupying 23 pages of the book. The first 12 deal with India in general while the remaining pages give references on specified parts of the country such as Andaman Islands, Andhra Pradesh, Arunachal Pradesh, Maharashtra etc.

Each entry also provides coded information regarding the language of the paper, whether a summary in English is given or not and type of information the article contains.

The compilers of this volume intend to produce periodical supplements and revised editions of this work and have expressed their desire to receive suggestions from readers regarding new and missing titles which could be incorporated in future publications. These suggestions, additions and corrections may be communicated to any of the following addresses:

Threatened Plant Unit, World Conservation Monitoring Centre, 219C Huntingdon Road, Cambridge CB3 ODL, or

Conservation Unit, Economic and Conservation Section (ECOS), Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB

M.R. ALMEIDA

A CHECKLIST OF BIRDS OF ANDHRA PRADESH. By Siraj A. Taher and Aasheesh Pittie. pp ix + 40 with 2 maps. Hyderabad, 1989. Published by the authors. Price Rs. 10.

Even during the process of its compilation, this checklist has been used by some birdwatchers studying the Andhra regions. However, it has taken the authors nearly five years to publish and circulate the list on a limited scale. As Humayun Abdulali comments in the foreword (written in 1987), regional checklists usually include nearly 30% of Indian avifauna and are thus useful and necessary. Abdulali further adds that local natural history societies (like the Birdwatchers Society of Andhra Pradesh) would in future encourage other local annotated checklists and catalyse detailed work on regional ornithologies.

The area under Andhra Pradesh formerly included parts of erstwhile Hyderabad, Mysore, Madras and other

small princely states. Topographically it comprises the Deccan Plateau, the Eastern Ghats with the Godavari, Krishna, Tungabhadra and Pennar rivers with their extensive deltas. This varied topography contains 58 avian families comprising 446 species according to the checklist – 75% of India's 77 avian families and 37% of the total number of species found in the country. Andhra Pradesh is the only state where the Jerdon's courser *Cursorius bitorquatus* is found. Also found are the endangered great Indian bustard *Ardeotis nigriceps* and the lesser florican *Sypheotides indica*. The pinkheaded duck *Rhodonessa caryophyllacea* has also been recorded here earlier.

The authors have listed their major sources of information in the Introduction and this list, along with the references at the rear, is a veritable ornithologist's delight. Personalities such as Hugh Whistler and Norman Boyd Kinnear in the Vernay Scientific Survey, Salim Ali in the Hyderabad State Survey, Humayun Abdulali in Visakhapatnam, and Dillon Ripley in the Eastern Ghats near Visakhapatnam, have at times looked at Andhra with more than general interest.

The introduction to the checklist also gives information about the region's topography. This could have been provided in more detail. Additionally, notes about locally rare birds such as the sarus crane *Grus antigone*, yellowthroated bulbul *Pycnonotus xantholaemus* and the little spiderhunter *Arachnothera longirostris* which have limited distribution should have been included.

A critical drawback in the checklist is that the status records for each species listed are confined to the vicinity of Hyderabad only instead of considering the entire state of Andhra Pradesh. It is typical of the 'elitist isolation' that some regional groups have fallen prey to by not being able to develop and organise birdwatchers in parts of their state outside their city. Future editions of the checklist could take into account status records of other areas from the various studies listed in the bibliography.

The two maps are not adequate in conveying information at a comprehensive level in relation to the importance of the bird-lists. While the map of India in the earlier copies had serious boundary errors (which have since been corrected in the later copies), the map of Andhra Pradesh is almost illegible.

The authors have taken care to adhere strictly to the criteria that the listed species should (1) have been reported in published literature for the state, (2) have been reported by highly reliable persons including the authors, and (3) be limited to binomials only for uncollected records.

The last mentioned criteria seems to have been tricky because of the paucity of definite information. Going ahead with the ambiguous assumption that "the races are more easily distinguishable at the extreme limits but move inwards to integrate at a common centre", the authors decided to accept and use (1) the race occurring in Andhra Pradesh, and (2) wherever the race could be easily identified in the field, e.g. *Milvus migrans lineatus*.

The listing for each species is followed by its Telugu and Hindustani name. Some of the Telugu names seem to be extraordinarily logical and hard to believe that such differentiation could be sustained historically by ethno-lingual justification. For example, (1) longbilled vulture– 'podugumukku boruvua' (= longnosed vulture) and whitebacked vulture– 'tella veepu boruva' (= whitebacked vulture), (2) orangebreasted green pigeon – 'pasupu pacha pavuramu' (= yellow green pigeon) and, (3) baya – 'pasupu pitta' (= yellow bird) and blackthroated weaver bird– 'nallagontu pichuka' (= blackthroated sparrow).

While spelling errors are plenty in the English as well as in the transliterated Telugu and Hindustani names, there are some errors in the listing itself. For example, the north and south indian crested goshawks have their races *indicus* and *peninsulae* listed wrongly for each other. some birds have been listed as an entirely different race, eg. eastern redlegged falcon *Falco vespertinus* should be *F. v. amurensis* in Andhra Pradesh and not *F. v. vespertinus* as mentioned.

BHARAT BHUSHAN

WEALTH OF INDIA – RAW MATERIALS, VOLUME 2: B (Revised Edition). A DICTIONARY OF INDIAN RAW MATERIALS AND INDUSTRIAL PRODUCTS. Editor-in-chief S.P. Ambastha. pp. i-xlii + 1 - 350 + 1-90 (29 x 22 cm). With 14 colour plates and 69 text-figures. Published by Publication and Information Directorate, CSIR, Hillside Road, New Delhi-110 012. New Delhi, 1988. Price Rs. 220, £ 45 or $ 80.

This second volume of the revised edition of Wealth of India covers alphabet 'B' of the new series and includes 251 plant species belonging to 86 genera, one article on bees and information about seven minerals.

The nomenclature of the plant species has been as far as possible brought up-to-date. However, it appears that the International Code of Botanical Nomenclature has not been given much weightage because some of the names adopted in the volume are in common use even if they are illegitimate names according to the Code (see note under *Brassica campestris* Linn.).

When names are formed by using the old epithet in a new generic combination, it is common practice in botanical nomenclature to mention the name of the

original author in parentheses to indicate the origin of the name. There are a number of names in this volume which do not have the name of the original author in parenthesis. For example,

1. *Biophytum sensitivum* DC. should read *Biophytum sensitivum* DC. (Linn.), the name Linnaeus being abbreviated as Linn.

2. *Blumea lacera* DC. should read *Blumea lacera* DC. (Burm.), the name Junior Burmann being abbreviated as Burm. f.

3. *Blumea laciniata* DC.should read *Blumea laciniata* DC. (Roxb.), the name Roxburgh being abbreviated as Roxb.

4. *Barringtonia acutangula* should read *Barringtonia acutangula* (Linn.).

Data on regeneration and plant propagation from seed germination, coppicing, stem-cutting and root-suckers are given much more in detail than in the earlier edition. General information on plants is also brought up-to-date. This volume is very useful for instant reference work and hence recommended for colleges and research institutions.

M.R. ALMEIDA

MISCELLANEOUS NOTES

1. STUMPTAILED MACAQUE *MACACA ARCTOIDES* (GEOFFROY) IN MANIPUR

During a visit to Manipur in April 1988 I came across three adult male stump-tailed macaques *Macaca arctoides* in the small zoo near Imphal city. All the three had been reportedly collected from the forests of Churachandpur district (23°57'N to 24°40'N, and 93°0'E to 93°50' E). They had not been identified, and about a dozen Assamese macaques *Macaca assamensis*, also locally collected and kept in a separate enclosure, had been wrongly identified as stumptailed macaques. This is the first specific record of the stumptailed macaque in Manipur. The main stronghold of the species is perhaps the Western Hills along the Assam-Manipur border.

August 8, 1989 ANWARUDDIN CHOUDHURY

2. INTERACTION BETWEEN A MALE TIGER *PANTHERA TIGRIS* AND HIS CUBS IN BANDHAVGARH NATIONAL PARK, MADHYA PRADESH

The following observations were made on a male tiger *Panthera tigris* Banka, a tigress, Sita, and their cubs in Bandhavgarh National Park, Madhya Pradesh, over a period of 30 months.

Banka was seen mating with Sita on 28 May 1986, when she was nearly 3 years old. Three cubs were seen with Sita in November 1986 and it is assumed that they were sired by Banka.

It was also determined, by plotting on a 1:50,000 scale map locations where Banka and Sita were seen or where their tracks were positively identified, that Banka's territory encompassed Sita's.

On 1 December 1986 when the cubs were about 10 weeks old, Banka was seen at a kill along with Sita and the cubs. Neither the cubs nor Sita showed any apprehension at the presence of the male.

On 25 February 1987 only two cubs were seen with Banka and Sita at a kill. On being disturbed Sita dragged the kill and hid it under a bush on top of a hill and went to collect the cubs. When she had brought them up, she was reluctant to go to the kill because of the presence of our elephant which the cubs were not willing to pass.

In the meantime Banka got to the kill which was about 70 m behind us and began making the high nasal *aeun* sound which seems to be both a contact call and a summons. Sita and the cubs reacted to this but again the cubs were unwilling to go past the elephant. After a few minutes Banka called louder and gruffer than before and this time we moved the elephant away whereupon Sita and the cubs went to the kill immediately.

By mid-February 1988 when the cubs were approximately 17 months old, Sita showed signs of disassociating herself from the cubs and was not seen with them for long periods. After 23 March she was next seen with them until 13 April. On 15 March Banka was seen in company with the cubs and the female cub was seen playing with him. They would also follow him around wherever he moved. All 3 tigers were seen together the whole day and on 18 March 1988 they were seen together again with the male cub close to Banka and the female cub 100 m away. There was no sign of Sita on any of these occasions.

On 13 April 1988 Mr. H.S. Pabla the then Director of the Park, and Mr. Vivek R. Sinha, saw Sita behaving aggressively towards her cubs. The cubs were then approximately 19 months old. Possibly this marked the beginning of the period leading the cubs to independence.

I would like to express my thanks to Dr Charles McDougal for his encouragement to write this note and to Vinay Asar and family for all their help.

August 30, 1989 HASHIM TYABJI

3. SIGHTING OF THE RUSTY SPOTTED CAT *FELIS RUBIGINOSA* (GEOFFROY) IN SHOOLPANESHWAR SANCTUARY, GUJARAT

The habitat of Shoolpaneshwar Sanctuary (21°23'N –21°59'N and 73°05'E–74°10'E) in Bharuch district, Gujarat, comprises of semi-moist deciduous to dry deciduous forest. The major floristic elements are teak *Tectona grandis* and bamboo *Dendrocalamus strictus*. The terrain is hilly and comprises of Deccan Trap basalt.

The rusty spotted cat *Felis rubiginosa* (Geoffroy) was first sighted on 26 November 1990 at 2230 hrs in a stream bed surrounded by dense forest near Namgir village. It was possible to observe it for 6.5 min. with the help

of a 4 cell torch from about 2 to 3 m.

The second sighting of the cat was made on 16 December 1990 at 2200 hrs in a small cultivated area near the same stream. This observation was made for about 3 min. and confirmed by S.A. Chavan. Since we had the photographs of the rusty spotted cat (taken in Gir by Bharat Pathak) there was no possibility of misidentification.

This cat had been recorded earlier in Dangs forests by H.H. Maharaja of Bansda. As Rajpipla forests, Sagbara, Mandvi, Vyara and Dangs formed a continuous corridor of moist deciduous forests in the past, there is every possibility that this species existed in this belt, but had not been identified earlier in Rajpipla forests.

S.A. CHAVAN
C.D. PATEL
S.V. PAWAR
N.S. GOGATE
N.P. PANDYA

March 12, 1991

4. BEHAVIOUR OF A JACKAL *CANIS AUREUS* AT A LEOPARD *PANTHERA PARDUS* KILL

On 2 March 1990 I sat over a cow killed by a leopard *Panthera pardus* in a ravine near Perohit-ji-ka-Talab, a small lake near Udaipur. The blind was 15 m from the kill and I took up my position in the hide at 1530 hrs. After a lapse of an hour I heard the alarm call of langur *Presbytis entellus* and 15 minutes later I saw a leopard descending on my right into the ravine. Probably it noticed the unnatural construction near the kill and sensed some danger so it stopped about 100 m from me behind some bushes, almost concealed from me. After some time it rose, took a long detour around the hide and took up its position about 40 m from the hide. Only the tail of the leopard was visible from my position. Here the terrain was undulating and strewn with boulders and thick bushes. Towards my left it was comparatively flat, with a few bushes.

Just before dusk I spotted a jackal *Canis aureus* approaching the kill from the left. It was in a highly nervous state, stepping carefully, sniffing constantly up and down and occasionally whipping around to look behind. It came to the kill and before feeding on it again looked carefully around.

At this moment the leopard gave a loud cough. The jackal turned round like lightning gave a low whining sound and fell head over heels. Regaining its feet it tried to run hard, but after taking two or three steps it again fell and did a complete somersault. It turned four somersaults, twice fell headlong on the ground and finally disappeared from sight. The leopard did not even rise to its feet. As darkness approached I left the blind and was greeted by the leopard with growls. On many occasions I have seen jackals on leopard kills but have never seen a jackal in such a panic.

April 4, 1990

RAZA TEHSIN

5. FOOD PIRACY BY JACKAL *CANIS AUREUS* FROM A JUNGLE CAT *FELIS CHAUS* IN CHHARI-DHANDH, KUTCH

On 27 May 1990 at 1930 hours, we were on a general reconnaissance of the terrain around Fulay village in Chhari-Dhandh, Kutch, Gujarat. About 4 km west of Fulay, we saw a jungle cat *Felis chaus* preying on a snake, and when observed it was walking, carrying its prey. Suddenly, from behind an *Euphorbia* thicket a jackal *Canis aureus* emerged and sprang on the cat, in an obvious attempt to snatch its prey. The cat resisted the jackal's efforts for some time during which a brief struggle ensued between the two. The jackal chased the cat for some distance and almost grabbed the prey during the first few attempts, but each time the cat managed to evade its assaults.

Finally the jackal snatched the dead snake from the cat, and disappeared behind the rocks. The cat too left the area after a brief attempt to regain its prey. This is the first instance of food piracy by a jackal from a jungle cat. Snakes have not been listed as a food item of either the jungle cat or the jackal so far.

S. ASAD AKHTAR
J. K. TIWARI

November 16, 1990

6. FROG-EATING HABIT OF LONGEARED HEDGEHOG *HEMIECHINUS AURITUS* AND GREY MUSK SHREW *SUNCUS MURINUS*

On 4 October 1990, at dawn (around 0600 hrs), a male longeared hedgehog (weight 275 g) was captured by a night-watchman in the World Forestry Arboretum, Jaipur. The animal was kept in a 0.40 m deep empty cemented nursery bed of 10 x 1 m size.

At night, at about 1930 hrs, when I went to observe the animal, it was eating a medium sized toad (*Bufo stomaticus*). The head of the toad was in the mouth of hedgehog and the dying toad was making some jerking motions with its hind legs. The hedgehog did not use its fore-legs to manage its prey. It chewed its prey steadily and finished it within three minutes. No residue was left.

On 2 November 1990, at about 2000 hrs, at the Arboretum, one of the night-watchmen rushed in to inform me that some unusual shrill sounds were coming from a *Parkinsonia aculeata* bush. I rushed to the spot and examined the area by torch light. A grey musk shrew *Suncus murinus* was repeatedly attacking a big *Rana tigerina*. The unfortunate frog was making the shrill cries. I watched this tussle for three minutes, and the cries were so loud that many people gathered around the bush. The talking and shouting of men and their flashing torches disturbed the shrew and leaving the frog it entered its hole near the roots of the *Parkinsonia* bush.

The frog was quite disabled and unable to move from the many wounds made by the shrew on both its hind legs. However, it was rescued and transferred to a safer place.

Both the events described here suggest that the insect-eating longeared hedgehog and its kin the grey musk shrew may predate on frogs and toads also.

January 7, 1991 SATISH KUMAR SHARMA

7. GREAT CRESTED GREBE *PODICEPS CRISTATUS* IN SAURASHTRA

On 2 January 1989 I went to Amarsar lake which is about 6 km from Wankaner city in Rajkot district, Gujarat. Amongst the usual quota of duck and coots that are found on the lake in winter, I saw a pair of great crested grebes *Podiceps cristatus* with 3 young ones, light coloured, smaller and with prominent dark striations on the neck. The 3 youngsters were keeping close together while the mother fed usually in their proximity. The male bird was normally swimming a little distance away from the group, though the largest of the 3 youngsters frequently went up to the male bird. It was evident that the great crested grebes had bred this monsoon on the lake. This is the first time I have seen youngsters of this grebe in Saurashtra. Though there are occasional records of this bird breeding in Gujarat, I am personally not aware of any published report of its breeding on the Saurashtra peninsula. The occurrence of the bird itself is very rare in Saurashtra.

The next day I observed a very interesting occurrence at the lake. The male great crested grebe caught a frog which had inflated itself to its maximum proportions and had stretched out its limbs fully, probably to prevent itself from being swallowed. Frogs are known to do this when they are caught by snakes. The male grebe was about 30 m away from the mother and the young and had started swimming towards its family. The largest of the 3 young ones swam towards the oncoming male. For a while it swam side by side with the male, stretching out its beak and demanding the frog from the male. After a minute or so the male allowed the young one to take the frog from him. The youngster swam away for a little distance with the male following it, shifted its grip, raised its beak and neck and swallowed the frog. I was able to take a number of photographs of this occurrence and though the birds were quite a distance away the sequence can be seen. When I tried to row myself in a small boat close to the 3 youngsters who were segregated from the parents, the female, instead of swimming away, crossed in front of my boat and went and joined her brood and then together the group swam away to the further end of the lake.

April 4, 1989 M.K. RANJITSINH

8. SIGHTING OF LEAST FRIGATE BIRD *FREGATA ARIEL* IN BOMBAY

In mid July 1988 a frigate bird *Fregata ariel* was seen at 1730 hrs soaring very low in company with pariah *Milvus migrans govinda* and brahminy *Haliastur indus* kites above the United Services Club promenade adjacent to the sea at the southern-most tip of Bombay. Its features were clearly visible and it was easily identified as an adult

male of the least frigate bird by the white patches under the wings and other characteristics as described by Ali and Ripley (1978) and Tuck and Heinzel (1980). Abdulali (1960) has discounted Ferguson's (1904) record as uncertain, though Ali (1970) and Faizi (1985) have included it as a record. To put the records straight, there are three previous records from India: an adult male (Abdulali 1960), a juvenile (Ali 1970, Faizi 1985). The present is the fourth for India. These records made in June and early July coincide with the south-west monsoon, indicating that the high speed monsoon winds probably sweep these vagrants to our western coast.

Prof. R.M. Naik and Taej Mundkur commented on an earlier draft.

March 5, 1989

RISHAD NAOROJI

REFERENCES

ABDULALI, H. (1960): Occurrence of the Least Frigate Bird *Fregata ariel* (G.R.Gray) in Bombay. *J. Bombay nat. Hist. Soc. 57(3):* 668.

ALI, RAUF (1970): Occurrence of Least Frigate Bird *Fregata ariel iredalei* Mathews in Bombay. *J. Bombay nat. Hist. Soc. 67 (3):* 569-570.

ALI, S. & RIPLEY, S.D. (1978): Handbook of Birds of India & Pakistan. Vol. 1. Oxford University Press, Delhi.

FAIZI, S. (1985) : An additional record of the Least Frigate Bird *Fregata ariel* in India. *J. Bombay nat. Hist. Soc. 82 (1):* 191.

FERGUSON, H.S. (1904): The Birds of Travancore. *J. Bombay nat. Hist. Soc. 16(1):* 13.

TUCK, G. & HEINZEL, H. (1980): A Field Guide to the Seabirds of Britain and the World. William Collins Sons & Co. Ltd., Glasgow.

9. GLOSSY IBIS *PLEGADIS FALCINELLUS* (LINN.) AND PAINTED STORK *MYCTERIA LEUCOCEPHALA* (PENNANT): TWO MORE ADDITIONS TO THE BIRD LIST OF KERALA

On 8 November 1987 , we were observing a group of about 60 cattle egrets *Bubulcus ibis* feeding in an uncultivated paddy field at Kattampally, a wetland near Cannanore. A dark coloured curlew-like bird among the egrets attracted our attention. Its upperparts were chestnut in colour and the tail black. The long, down-curved bill and legs were also dark. From the feathered head and the absence of white colour on the body, we identified the bird as a glossy ibis *Plegadis falcinellus*. After some time, a marsh harrier *Circus aeruginosus* glided overhead and the whole group took off. The cattle egrets settled near us while the glossy ibis circled overhead for several minutes. Its rounded wings and chestnut underparts could be observed clearly. On 28 October 1987, one of us (C. S.) had observed seven birds of this species in flight near the same place, which could not be identified at that time. This species has never been reported from Kerala before.

The Parassinikadavu Snake Park about 13 km from Cannanore has, apart from snakes, a collection of several wild animals and birds, most of them donated by people all over Cannanore and Kasaragod districts of north Kerala. On hearing of the arrival of a rare bird at the Park, we visited it on 26 January 1988. The bird turned out to be a painted stork *Mycteria leucocephala*. It had been found in a paddy field in Eramam village, about 30 km north of Cannanore, in the first week of January 1988. The bird being uncommon, the villagers caught and handed it over to the Snake Park. Though very weak and probably injured when it was brought to the Park, the bird seemed to be recuperating on a diet of fish, frogs etc. This species also is being reported from Kerala for the first time.

C. SASHI KUMAR
C . JAYAKUMAR
MUHAMMED JAFFER

April 4, 1989

10. A STRANGE PREDATORY HABIT OF THE PARIAH KITE *MILVUS MIGRANS*

We were watching birds along the banks of the Kudamuruti, a branch of the Uyyakondon Canal of the Cauvery river, in the early morning on 29 April 1989. More than ten male baya weaver birds *Ploceus philippinus* were making nests in a male palmyra tree. The nests were in different stages of construction. A pariah kite *Milvus migrans* glided to the vicinity of the nest tree and all the bayas, alarmed, flew to nearby plantain and other trees. The predator seemed unconcerned with the adult nest builders. Thrice it circled the tree, turned each time upside down and clung on with its talons to a partially built nest with wings spread. It selected only those nests whose egg

chambers had been completed. After hanging upside down for a minute or so it heaved itself into the air, the talons still stuck into the wall of the nest. At the first attempt it could not dislodge the nest from the base. But in the second attempt a nest was carried away in the talons of both the feet, deposited on the flat base of a leaf of the palm, inspected and abandoned. The unsuccessful third attempt with regard to snapping off the nest was strange in that the kite held two nests, one in each foot. How long the predator went on in this fashion is not known.

That such open-nest birds such as crows do not tolerate a pariah kite's presence is a common sight. The kite is known to be a "menace to young chickens and ducklings in poultry runs" (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali S. and Ripley, S.D. 1978). Could the observed habit be an acquired one? That the predator did not know the breeding cycle of the prey species, expecting eggs or nestlings in the nests at that stage of nest construction, is perhaps evidence that it is a habit developed recently in the bird, perhaps locally.

H. DANIEL WESLEY
A. RELTON
A. ALAGAPPA MOSES

June 15, 1989

11. CINEREOUS VULTURE *AEGYPIUS MONACHUS* (LINN.) IN PATHANAMTHITTA, KERALA

Four species of vultures have so far been recorded in Kerala, namely the black or king vulture *Sarcogyps calvus*, the longbilled vulture *Gyps indicus*, the whitebacked or Bengal vulture *Gyps bengalensis* and the smaller white scavenger vulture *Neophron percnopterus*. A new and rare species has now been added to this list, namely the cinereous vulture *Aegypius monachus* (Linn.), also known as the Himalayan vulture. It is being reported for the first time from south India, the previous southernmost limit of the bird's winter wanderings being Madhya Pradesh.

The bird was first seen at Kanjirappara, at an altitude of just around 30 m, near Mallapuzhassery in Kozhenchery taluk of Pathanamthitta (9°3' to 9°30 N, 76°30 to 77°15 E), a hilly district of Kerala in the first week of December 1988. The local people were excited when they spotted it, because such large-sized birds had not been seen before in the area. They caught the somewhat exhausted bird and handed it over to the Forest Department and it was in turn gifted it to the Trivandrum Zoo.

The cinereous vulture is a large, uniformly black, or blackish brown, vulture with naked, light pinkish neck surrounded by a distinct blackish ruff. The head is partially naked and conspicuously broader than in other vultures. It has no fleshy wattles on the sides of the neck. In overhead flight its broader wings without whitish stripe and the slightly wedge-shaped tail distinguish it from the king vulture.

A rare and sparse winter visitor to Sind, north-west and north India (including Nepal), Kutch, north Gujarat and central India, it affects savannah and semi-desert country and avoids forest. Within our limits it breeds only in Baluchistan between *c*. 2400 and 3000 m elevation and in the Barail Range of North Cachar at *c*. 1800 m. The nesting season is apparently March and April, though eggs have been taken in Assam in January and May.

January 18, 1989. R.S. SHREE KUMAR

12. GREYHEADED LAPWING *VANELLUS CINEREUS* (BLYTH) IN GOA

Gary Featherstone of Doncaster (U.K.), an experienced ornithologist on a three-week visit to Goa, informed me on 2 January 1989 about the presence of two greyheaded lapwings *Vanellus cinereus* (Blyth) a few hundred metres behind the Hotel Ronil where he was staying, at Calangute Beach, Bardez, North Goa (15°32'N, 73°53'E). In the evening of the same day, we went together to the site and indeed found a single specimen of this species in a small dry sandy marsh that is periodically inundated by saline water when the adjacent Baga creek rises during spring tides.

The bird was immediately distinguishable from the not dissimilar yellowwattled lapwing *Vanellus malabaricus*, a quite common species in Goa (though not in this locality) by the following features: its more substantial size, absence of the black crown, the lack of fleshy 'wattles' on the less extensive bare yellow skin of the forehead and the far greater expanse of white in the wing when in flight. No pectoral band was observed, suggesting that the bird was an immature. We were able to watch the bird clearly with 10 x 40 binoculars.

The greyheaded lapwing is known as a winter visitor to the north- eastern states of India, straggling as far south as the Andaman islands and as far west as Bharatpur, Rajasthan (27°13'N, 77° 32'E) (Grubh, R.B. *JBNHS 65*: 484), making this sighting the first record of the species from the Indian peninsula and *c*. 1300 km distant from the closest previous record.

March 31, 1989 HEINZ LAINER

13. BLACK WOODPECKER *DRYOCOPUS* SP. IN JALDAPARA SANCTUARY, WEST BENGAL

On 8 November 1988 we were birdwatching in the Jaldapara sanctuary in West Bengal. At around 1600 hrs, near the Jaldapara rest house about 500 m from the Forest Rest House, we saw a bird fly across towards Jaldapara village. It was distinctly a black-and-red bird with lighter coloured eyes. We both immediately identified it as the black woodpecker *Dryocopus sp*.

On referring to the literature, we realised that the bird was far outside the range mentioned by Ali and Ripley (1983 a, b)*. They mention only two subspecies, namely [1] *Dryocopus javensis hodgsonii*, with a white belly and rump, found in the Western Ghats and in the east up to Bastar (Ali mentions that it possibly may also occur in the Eastern Ghats and Orissa) and [2] *Dryocopus javensis hodgei*, found only in the Andaman islands and which has no white in the plumage. Since we did not see any white in the plumage, we decided to investigate further.

Ripley (1982) gives the possible occurrence of one more subspecies *Dryocopus martius khamensis* in the neighbouring areas of Arunachal Pradesh between 2800 m to 3800 m in the temperate forests, in Tsangpo Valley, Nang Dzong to Gyala (*c*. 93°15'E) and Tongkyuk valley (*c*. 95°E). Short (1982) gives the distribution and habitats of *D. martius* as follows: Eurasian bird ranging from Scandinavia, the Pyrennes and France across Europe to Asia Minor through Russia to Siberia, south Caucasus, north Iran, north Mongolia, north China, Sakhalin, Hokkaido, north Honshu with isolated records in Tibet, Yunan and west Szechwan. It is found in mixed coniferous forests and also in parks with large trees. It occurs from sea level to an elevation of 950 m in most of the regions, although found as high as 4300 m in the Tibetan mountains. This species also does not have any white in the plumage, and several subspecies are known.

Smythies (1953) has three subspecies – *D. javensis javensis* in Tenasserim of south Burma; *D. javensis feddeni* in Arakan and Chin hills of central Burma; and *D. javensis forrestsii* above 1500 m in north-western Burma. All three subspecies have varying amounts of white in their plumage.

Jaldapara lies at approximately 89 °E, 28°N, in terai forest consisting of sal forests interspersed with huge areas of elephant grass, at the base of the Bhutan hills on the banks of the river Toorsa. The bird was seen in the sal forest. Since we were there only for a day we could not make any further investigations.

We are still uncertain about the species/subspecies of the woodpecker we saw. Since it had no white in the plumage it could be either *D. javensis hodgei* or *D. martius*. The former is limited to the Andamans, far away from Jaldapara, and also island evolution is very different from that of the mainland. *D. martius* is a widely distributed species, and the longitude of its occurrence in the nearby Tibetan region is much closer than that of any other species. The bird we saw is hence probably *D. martius*. It is not known to be a migrant, hence its occurrence as an accidental migrant or vagrant is ruled out. The bird must therefore be a resident of Jaldapara.

We request naturalists visiting this sanctuary and the nearby regions to look out for this woodpecker.

MEENA HARIBAL
USHA GANGULI- LACHUNGPA

June 15, 1989

*There is no mention of *D. martius* in Ali and Ripley (1983b), and *D. javensis hodgsonii* has been incorrectly labelled in the plate as *D.j. hodgei*. For the correct illustration, see Short (1982) p. 616, pl. 78

REFERENCES

ALI, S. & RIPLEY, S.D. (1983 a): A Pictorial Guide to Birds of the Indian Subcontinent. Bombay Natural History Society, Bombay.

ALI S & RIPLEY, S.D. (1983 b): Handbook of the Birds of India and Pakistan. Compact edition. Oxford University Press, Bombay.

RIPLEY, S.D. (1982): A synopsis of the Birds of India and Pakistan 2nd edition. Bombay Natural History Society, Bombay.

SHORT, L.L. (1982): The Woodpeckers of the World. Delaware Museum of Natural History, Greenville, Delaware, Monograph series Number 4.

SMYTHIES, B.E. (1953): The Birds of Burma. 2nd revised edition. Oliver and Boyd, Edinburgh and London.

14. COMMENTS ON SAP-SUCKING BY WOODPECKERS IN INDIA

Abdulali (1968) discussed the phenomenon of systematic sap- sucking by an unidentified woodpecker in the hills of Kashmir. His photograph of the bark workings of this woodpecker are remarkably suggestive of work done by species of sapsuckers *(Sphyrapicus* spp.) from North America. To my knowledge, *Picoides major* of Eurasia is the only other species known to drill bark specifically to produce sap (Short 1982). It is remarkable that a single genus in North America, and a single species each in Eurasia and south Asia are the only examples of this un-

usual foraging method, and for this reason I wish to comment on Abdulali's note, and offer additional thoughts on the probable identity of the Indian sapsucker.

It seems certain that the Indian sapsucker is *Hypopicus hyperythrus* Abdulali rightly noted that in the SYNOPSIS (Ripley 1982) I have used the name 'Rufous-bellied Sapsucker' in reference to this species, one of the pied woodpeckers, ranging from the Himalaya, north-eastern India and south-east Asia, to southern China, Korea and Manchuria. Two sources support the notion that *Hypopicus* is the Indian sapsucker that produced the systematic drill holes so prominent in Abdulali's photograph. The first is Osmaston (1916), who noted this phenomenon in Kumaon, and who actually observed *Hypopicus* visit the holes, in order to drink the sap exudate.

Additionally, Zusi and Marshall (1970) implicate *Hypopicus* both by the field observations of Marshall, and by the anatomical examination of the tongue by Zusi. Marshall, like Osmaston, observed *Hypopicus*, and no other woodpecker, visiting the rows of bark holes that he found on trees in Thailand. Zusi's examination of a *Hypopicus* tongue shows that its tip is adorned with fine, soft, brush-like edges, very similar to those found on the tongue of the North American sapsucker, and quite unlike the coarser and stiffer tongue structure found in other related species of woodpeckers never known to feed on sap exudate.

One of the reasons that Abdulali doubted that *Hypopicus* was the creator of the bark-holes that he photographed in Srinagar was that he did not believe the species occurred there. It is now known that *Hypopicus* does, indeed, range westward through Kashmir to northern Pakistan (Ripley 1982).

What is most remarkable is that, to date, there have been no direct observations of *Hypopicus hyperythrus* drilling the rows of bark holes, so that the knowledge of this species' remarkable drilling habit remains based only on indirect evidence. It would be valuable for naturalists living in the Himalayan hill stations to make an effort to provide direct observations on the drilling and sap-sucking activities of *Hypopicus hyperythrus*. In particular, it would be interesting to know the relative importance of sap in the diet of this species, and the nutritional constituents of the sap of the particular tree species most commonly used. It has been stated that sap-sucking by this form occurs only in the spring (Zusi and Marshall 1970).

One might ask whether the sap is used preferentially for provisioning nestlings. A diet high in carbohydrates might be the answer.

March 8, 1989 S. DILLON RIPLEY

REFERENCES

ABDULALI, H. (1968): Sap sucking by Indian woodpeckers. *J. Bombay nat. Hist. Soc. 65:* 219-221.

ALI, S., & RIPLEY, S.D. (1987): Handbook of the birds of India and Pakistan. Compact Ed. Oxford University Press, New Delhi.

OSMASTON, B.B. (1916): Curious habits of wood-peckers in the Kumaon hills. *J. Bombay nat. Hist. Soc. 24:* 363-366.

RIPLEY, S.D. (1982): Synopsis of birds of India and Pakistan, 2nd ed. Bombay Natural History Society, Bombay.

SHORT, L.L. (1982): Woodpeckers of the world. Monogr. 4. Delaware Museum of Natural History, Greenville, Delaware (USA).

ZUSI, R.L. & MARSHALL, J.M. (1970): A comparison of Asiatic and North American sapsuckers. *Nat. Hist. Bull. Siam Soc. 23:* 393-407.

15. LONG DISTANCE MOVEMENT OF A MALABAR WHISTLING THRUSH *MYIOPHONUS HORSFIELDII* (VIGORS) IN THE WESTERN GHATS

During the BNHS bird ringing camp at Mahabaleswar, Satara district, Maharashtra (17°55'N, 73°40'E, 1371 m.a.s.l.) we had mist-netted 59 birds of the Malabar whistling thrush *Myiophonus horsfieldii* between 12 April and 18 June 1972. One individual (Ring No. B-31672) ringed on 13 June was recorded by U.K. Koragappa, the headman of Chembu village, Post Sampaje, North Coorg, Karnataka (12°00'N, 75°50'E), having been killed by a predatory bird near his house on 18 January 1976. He managed to recover the ring from the dead bird.

The distance travelled by the thrush was approximately 650 km south of the ringing place. It was recovered after 3 years, 7 months and 9 days.

There is considerable lack of information on migration and movement of birds along the Western Ghats complex. The above ring recovery of the Thrush is of interest and worthy of record. This recovery suggests that the species is not exclusively resident as has been previously recorded (Ali, S. and Ripley, S.D. 1987, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN 9:78) but probably has a wider distribution during the monsoon when it breeds. It is restricted to perennial water sources in evergreen areas during the dry months.

March 2, 1989 V.C. AMBEDKAR

16. PURPLERUMPED SUNBIRD *NECTARINIA ZEYLONICA* (LINN.): A NEW RECORD FOR ASSAM

The purplerumped sunbird *Nectarinia zeylonica* was hitherto unrecorded in Assam. At about 1415 hrs on 19 April 1988, I saw one male of this species in the garden of the local sub-divisional veterinary office compound, located in the heart of Hailakandi town in southern Cachar district.

According to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983) the nearest area where the purplerumped sunbird is found is southern Bangladesh (up to Dhaka in the north) and extending to Arakan. The species seems to have been overlooked on many occasions. It is apparently an uncommon resident of the Barak valley districts of Cachar and Karimganj.

March 31, 1989 ANWARUDDIN CHOUDHURY

17. HYBRID HOUSE SPARROW–TREE SPARROW FROM ARUNACHAL PRADESH

On 3 January 1981, the senior author collected three *Passer* specimens at Deban, 22 km east of Miao, Tirap district, Arunachal Pradesh (altitude 330 m). These three specimens were tentatively identified as tree sparrows *Passer montanus hepaticus*, and deposited in the collection of the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Later, while carrying out a complete review of our collections of birds from Arunachal Pradesh, we found that one of the *Passer* specimens (USNM No. 585161) appears to be a hybrid *montanus* x *domesticus*. This is of interest for two reasons. It apparently is the first evidence of hybridization between the house sparrow and the tree sparrow in India (Baker 1926, Ali and Ripley 1987), and it may represent the first specimen record proving the occurrence of *domesticus* in the hills of Arunachal Pradesh (see Ripley 1982: 537).

The putative hybrid is a male (testes not enlarged) in adult, non-breeding plumage, with measurements (in mm) as follows: wing chord 72; wing arc 74; bill from skull 14; bill from feathering 11; tail 52; tarsus 18; weight 18 g. Most of these measurements would accord well with the range of measurements of either species, but the weight agrees more closely to *montanus*, as does the short tarsus.

This specimen shows five characters that agree with *montanus*, one character that agrees with *domesticus* and three characters that are intermediate between the two presumed parental types.

The single, but very prominent, pure *domesticus* character is the buff-grey cap and nape, indistinguishable from typical *Passer domesticus indicus* the population recorded from north-eastern India.

Plumage characters intermediate between *montanus* and *domesticus* are: (1) brown lores contrasting with the grey cap (entire cap grey in *domesticus*, entire cap brown in *montanus*); (2) cheek spot is an apparent, but obsolete, dark grey smudge (entirely absent in *domesticus*; and a well-delineated black spot in *montanus*); and (3) chestnut streaking on mantle is apparent (much more dominant in *domesticus*, absent in *montanus*.)

Plumage characters that agree with pure *montanus* are: (1) the twin buff-white wing-bars (lacking the prominent anterior white wing-bar of *domesticus*); (2) chin stripe and bib are narrow, short, and not much expanded posteriorly (much more prominent in *domesticus*); (3) abdomen dirty buff (not clear pale buff as in *domesticus*); (4) rump buff-brown (not pale buff-grey as in *domesticus*).

Outside of the Indian region, the two species have been reported to hybridize in a few localities (Albrecht 1983, Hume 1983, Goselj 1985); and yet *P. domesticus* is much better known to interbreed with the Spanish sparrow *P. hispaniolensis*, with which it also co-occurs over a considerable range (Vaurie 1959).

Although the geographic ranges of house and tree sparrows generally meet all along the Himalayan cordillera, only in a few sites do the two exhibit true within-site sympatry. The two sort out by habitat, the tree sparrow generally occurring at higher altitudes, and in less urban locales. Krishna Raju and Price (1973) found both house and tree sparrows inhabiting villages in the Chintapalle plateau of the Eastern Ghats. Price (1979) reported an unconfirmed observation of a hybrid at the village of Bussalkort. We should note that our search for the populations of *montanus* on this same plateau in 1985 failed (Ripley *et al*. 1988). Has the house sparrow completely replaced the relict population of the tree sparrow in the Eastern Ghats?

Deban, Arunachal Pradesh, where our hybrid specimen was taken, lies at the foot of the Dapha Bum range, at an altitude that may be low for *montanus* and at the upper edge of the altitudinal range of *domesticus*. We presume that hybrids between these two species will be found by future ornithologists who focus on the non-forest avifauna of the hills of north-eastern India.

S. DILLON RIPLEY
BRUCE M. BEEHLER

March 5, 1989

REFERENCES

ALBRECHT, J.S.M. (1983): Courtship behaviour between tree sparrow and house sparrow in the wild – a possible case of hybridization. *Sandgrouse no. 5:* 97-99.

ALI, S. & RIPLEY, S.D. (1987): Handbook of the Birds of India and Pakistan, 2nd Compact Edition. Oxford University Press, Delhi.

BAKER, E.C.S. (1926): The Fauna of British India. Birds, vol.3. Taylor & Francis, London.

GROSELJ, P. (1985): [Hybrids of *Passer montanus* and *Passer domesticus* in Solvenia also]. *Proteus 48:* 71-73 [in Slovenian; extracted from the Zoological Record].

HUME, R.A. (1983): Hybrid Tree x House Sparrow paired with House Sparrow. *British Birds 76:* 234-235.

KRISHNA RAJU, K.S.R., & PRICE, T.R. (1973): Tree Sparrow, *Passer montanus* (L.) in the Eastern Ghats. *J. Bombay. nat. Hist. Soc. 79:* 557.

PRICE, T.D. (1979): The seasonality and occurrence of birds in the Eastern Ghats of Andhra Pradesh. *J. Bombay nat. Hist. Soc. 76:* 379-422.

RIPLEY, S.D. (1982): Synopsis of the Birds of India and Pakistan. Second Edition. Bombay Natural History Society, Bombay.

RIPLEY, S.D., BEEHLER, B.M. & KRISHNA RAJU, K.S.R. (1988): Birds of the Visakhapatnam Ghats, Andhra Pradesh, Pt. 2. *J. Bombay nat. Hist. Soc. 85:* 90-107.

VAURIE, C. (1959): The Birds of the Palearctic Fauna. Passeriformes. H.F. & G. Witherby, London.

18. FURTHER NOTES ON PRESENCE OF FRUITS OF *XANTHIUM INDICUM* KOENIG IN THE NESTS OF *PLOCEUS PHILIPPINUS*

On 21 August 1984 at Tatarpur Mixed Plantation in Alwar district, Rajasthan, I observed a single 'fruit' of *Xanthium indicum* in a completed nest of *Ploceus philippinus*. Its significance remained obscure (Sharma 1988). Subsequently, the whole locality was surveyed but none of the nests in any colony was seen having 'fruits' of *X. indicum* in it. The question of how and why *X. indicum* fruit reached the baya nest remained unresolved.

During 1985 and part of 1986 I was away from Rajasthan and hence could not pursue the study. In July 1986, after returning to Udaipur I selected a baya colony on a medium sized *Phoenix sylvestris* tree near Sitamata Forest Nursery for further study. I tied a twig of *Xathium indicum* with fruits intact, on a date palm to test the affinity of breeding bayas for *Xanthium* fruits. Observations were made for two weeks but neither male nor female birds showed any interest in the fruits. The same experiment was repeated in August 1987 in the locality, with the same results. It thus seems clear that it was not the baya which carried the *Xanthium* 'fruit' to the nest.

When the fruit of *Xanthium indicum* was seen for the first time in Alwar district, further attempts were made to discover the mysterious fruit carrying agency. A sampling survey was conducted from September 1988 to January 1989 in degraded forests and agricultural fields. In January, while I was collecting baya nests near the small village of Shyopur, the four year old question was answered – the culprit was the longtailed tree mouse *Vandeleuria oleracea*.

During the sampling survey, 13 nests of *Ploceus philippinus* were collected which had been 'parasitized' by the longtailed tree mouse. Three of the nests contained gnawed pieces of half eaten fruits of *Xanthium indicum*. The tree mice were physically present in seven nests including the three which contained *Xanthium* fruits. The remaining six nests contained mice nests inside, but their occupants were not present at the time of observation.

It was observed that fruits of *Xanthium indicum* are used as food during times of food scarcity. In Rajasthan the kharif crop is generally harvested from the end of October to mid November. At that time, grain remaining in fields and threshing floors serves as food. From December onwards, food scarcity grows and the longtailed tree mouse collects *Xanthium* fruits as an alternative source of food in those areas where *Xanthium* grows wild.

To confirm the food value of *Xanthium* fruits for the tree mouse, five mice were collected from baya nests and kept in a dark room in a cage in the second fortnight of January at World Forestry Arboretum, Jaipur. Four different types of items were given as food to the mice to see

TABLE 1
FOOD OFFERED TO CAPTIVE LONGTAILED TREE MICE

Food item	Remarks
Fruits of *Xanthium indicum*	*Extensively eaten.*
Wheat (Chapati)	Occasionally eaten.
Seeds of *Leucaena leucocephala*	Not eaten.
Leaves of *Portulacaria afra*	Occasionally eaten. Perhaps used as a source of water and salt.

their preference (Table 1). Water was not given. It was noticed that fruits of *Xanthium indicum* was their prime choice.

I am grateful to Dr Shiv Sharma, Department of Botany, University of Rajasthan, Jaipur, for his valuable guidance, and to A.K. Jain for typing the manuscript.

May 3, 1989 SATISH KUMAR SHARMA

REFERENCES

SHARMA, S.K. (1988): Presence of fruit of *Xanthium strumarium* in the nest of *P. phillippinus*. *J. Bombay nat. Hist. Soc. 85(3)*: 620.

SHARMA, S.K. (1988): Tendency of Cannibalism in the Longtailed Tree Mouse *Vandeleuria oleracea* (Bennett). *Rodent Newsletter 12 (1 &2)*: 2-3 (CAZRI, Jodhpur).

19. SALTWATER CROCODILE *CROCODYLUS POROSUS* IN ANDHRA PRADESH

(*With a text-figure*)

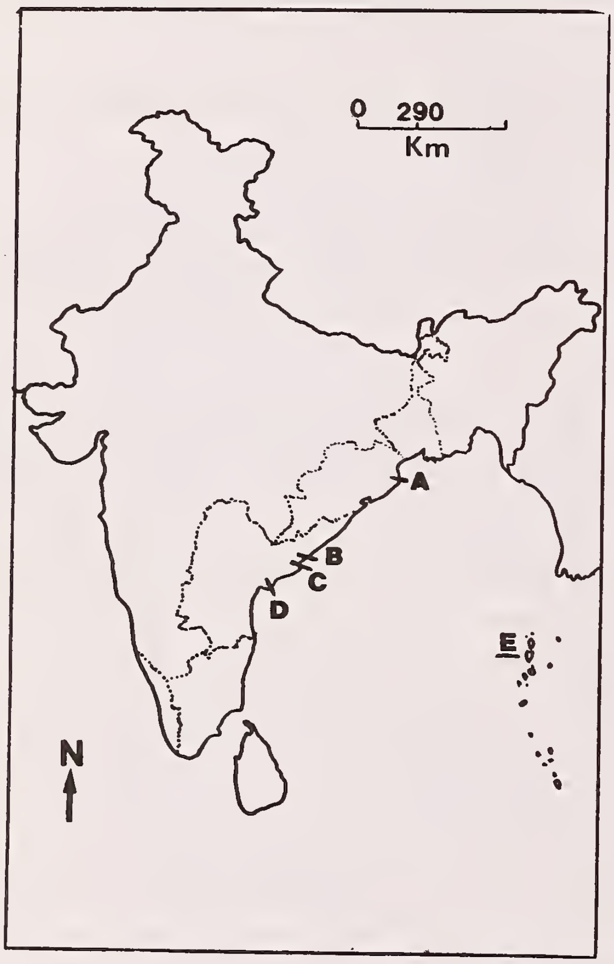


Fig. 1. Map of India showing capture points of saltwater crocodile. A . Gahirmatha beach, B. Capture point–1989 (this report), C. Coringa Wildlife Sanctuary, D. Capture point–1979 , E. Andaman islands.

On 18 January 1989 a juvenile saltwater crocodile *Crocodylus porosus* (1.5 m size) was caught in the sea by some fishermen near Moolapeta village, East Godavari District, Andhra Pradesh. The capture point was 25 km north of the Coringa Wildlife Sanctuary (Fig. 1). The crocodile was brought to the village, photographed and later taken possession of by the Andhra Pradesh Forest Department.

In India the species is present in Orissa and West Bengal in the mainland and in the Andaman and Nicobar Islands (Bustard and Choudhury 1980b, Kar 1981, Singh 1986). By 1975, the species was extinct in most of its former ranges in India including Kerala, Tamil Nadu and Andhra Pradesh (Bustard and Choudhury 1980b).

In 1978, a total of 3 saltwater crocodiles (1.2 m size) were released in the Coringa Wildlife Sanctuary (Godavari delta) (Bustard and Choudhury 1980b) as a part of the programme on crocodile rehabilitation. Unpublished reports revealed that these crocodiles were killed immediately by the local fishermen. There has been no further release in the Sanctuary since then. Bustard and Choudhury (1980a) reported that a 3.3 m saltwater crocodile caught in Krishna Estuary, Andhra Pradesh, on 11 January 1979 may have come from the Andamans (Fig. 1). Whitaker (1982) reported that a male *C. porosus* 2.8 m in length and 80 kg in weight was captured by fishermen in Karaikal, Tamil Nadu. He assumed that the crocodile might have come from Trincomalee on the east coast or Puttalam on the west coast of Sri Lanka, the nearest *porosus* populations to Tamil Nadu. He pointed out that saltwater crocodiles cross great gaps of sea between islands but coastal migrations are probably more frequent.

Kar and Rao (1985), while reporting the unusual sighting of a gharial *Gavialis gangeticus* on Gahirmatha beach (Fig. 1), stated that the sea currents on this coast are from south to north, which helped the gharial to move northwards. If this is true, then the saltwater crocodile caught off the Andhra coast at Moolapeta in January 1989 might have come from Andaman islands, travelling approximately 1100 km through open sea, an inference which is similar to the conclusion by Bustard and Choudhury (1980a). Both instances occurred during the month of January (1979 and 1989). The sea currents between Andamans and Andhra Pradesh during January may have helped the crocodiles to travel to the Andhra coast, and the possibility of the crocodile coming from Orissa and West

Bengal may be ruled out due to the opposite direction of water currents.

I am grateful to R. Mani for sending information on the saltwater crocodile, and to Dr L.A.K. Singh for comments on the manuscript.

May 4, 1990

R.J. RAO

References

Bustard, H.R. & Choudhury, B.C. (1980a): Long distance movement by a saltwater crocodile (*Crocodylus porosus*). *British J. Herpet. 6:* 87.

Bustard, H.R. & Choudhury, B.C. (1980b): Conservation future of the saltwater crocodile (*Crocodylus porosus* Schneider) in India. *J. Bombay nat. Hist. Soc. 77 (2):* 201-214.

Kar, S. (1981): Studies on the saltwater crocodile *Crocodylus porosus* Schneider. Ph.D. thesis, Utkal University, Orissa.

Kar, S. & Rao, R.J. (1985): A Gharial at Gahirmatha coast, Orissa. *J. Bombay nat. Hist. Soc. 82(3):* 671-674.

Singh, L.A.K. (1986): Crocodiles: Status and management. *In:* Wildlife wealth of India. (Ed.) T.C. Majupuria, Tecpress service, Bangkok.

Whitaker, R. (1982): Saltwater crocodile in S. India – first record for forty years. *Hamadryad 7 (2):* 12.

20. OCCURRENCE OF CONGENITAL BLINDNESS IN GHARIAL *GAVIALIS GANGETICUS* (REPTILIA: CROCODILIA)

Introduction

During 1975 out of 70 eggs of gharial *Gavialis gangeticus* incubated at the Gharial Research and Conservation Unit, Tikerpada, two hatchlings were blind (Subba Rao and Bustard 1979). During 1976, 60 eggs were incubated at Katerniyaghat, which produced one blind gharial (Singh and Tandan 1978). Again at Tikerpada, during 1976 three blind gharials were produced from 140 eggs (Singh and Bustard 1982a). All these instances relate to eggs which originated from Gangetic rivers of Karnali-Girwa and Kali-Narayani-Gandak in Nepal or in India, along the Indo-Nepal border. This feature had then led us to suggest the possible presence of a deleterious 'blind' gene in the populations of gharial in these rivers.

Here we present information recorded after the hatching of a blind gharial in captivity at Nandankanan Biological Park, Orissa. We also discuss the general frequency of occurrence of blindness reported for the species hitherto. Retarded growth in blind gharial, as observed by Singh and Bustard (1982b) has also been observed at Nandankanan.

Results

Captive gharials at Nandankanan bred for the first time during 1980. There were two females, Juli and Mili, both procured from river Mahanadi during 1963 and 1964. The male, with an uncertain origin, was received from the Frankfurt Zoo in 1979.

On 20 March 1982, Mili laid 28 eggs. 12 were left for incubation *in situ* and 16 were shifted for hatchery-incubation. In the breeding pen six young ones hatched on 29 May 1982. These included one blind hatchling. All six, along with eight others hatched in the hatchery on 2 June, were shifted to hatchling pools for rearing under identical husbandry conditions.

The blind gharial did not have any trace of the eye and fitted the description and photograph given by Singh and Bustard (1982a). On 10 August 1988 the blind gharial died when its SV length was 59 cm, total body length 120 cm and body weight 4.800 kg.

Discussion

Frequency of blindness: The frequency of occurrence of blindness in gharial as per the published information (Singh and Tandan 1978, Subba Rao and Bustard 1979, Singh and Bustard 1982a) and the present observation are 1.67% at Girwa (Katerniyaghat), 2.86% and 2.14% at Tikerpada, 0.42% at Chitwan and 3.57% at Nandankanan. Only the last record is from captive breeding while the others are from eggs collected from the wild. The mean frequency is 2.1% ± 1.2% of the total eggs incubated.

Though the origin of the male which participated in captive breeding at Nandankanan is not known, its origin from the Gangetic system along Nepal/India terai cannot be ruled out. If such an origin is correct then the possible presence of a deleterious 'blind' gene in the concerned region can gain further ground. If the origin is from somewhere else, then either the male or the female could have been responsible for the blindness. Since no further blindness in gharial have been recorded from any of the places mentioned earlier, it is argued that 'blindness' is one of the 12 congenital defects recorded for the species by Singh and Bustard (1982a) and can occur at any time like any other defect. However, it is an observed fact that blind gharials need to be helped out of the egg and the whole process of captive management and gharial conservation had received greater attention and care during the period from which all published reports have come. Therefore, the possibility of 'having missed to help a blind gharial

out of the egg' cannot be ruled out. In such a case, the frequency of occurrence of blindness can be accepted as 2.1% of the eggs incubated.

Retarded growth: Singh and Bustard (1982b) recorded 186 cm and 15.4 kg for the blind gharial five years after hatching, against 278 cm and 71.8 kg for normal gharial captive reared under identical conditions at Tikerpada. In the present study we recorded 120 cm and 4.8 kg nearly 6.5 years after hatching for the blind gharial at Nandankanan. These data indicate that blind gharials are not only difficult to hatch alive but also do not grow at normal rates.

We are grateful for facilities received from the Principal Chief Conservator of Forests and Chief Conservator of Forests (Wildlife), Orissa. Office facilities were availed by LAKS at Similipal Tiger Reserve.

L.N. ACHARJYO
L.A.K. SINGH
S.K. PATTANAIK

August 1, 1990

REFERENCES

SINGH, A.N. & TANDAN, B.K. (1978): Significance of the absence of optic nerves in a teratological specimen of *Gavialis gangeticus* (Reptilia, Crocodilia). *Cheetal 19:* 55-56.

SINGH, L.A.K. & BUSTARD, H.R. (1982a): Congenital defects in the gharial *Gavialis gangeticus* (Gmelin). *British Journal of Herpetology 6:* 215-219.

SINGH, L.A.K. & BUSTARD, H.R. (1982b): Growth and behaviour of a blind gharial *Gavialis gangeticus* (Gmelin). *J. Bombay nat. Hist. Soc. 79(3):* 681-684.

SUBBA RAO, M.V. & BUSTARD, H.R. (1979): Sequence of hatching of a blind baby gharial, *Gavialis gangeticus* (Gmelin) (Gavialidae, Crocodilia, Reptilia). *Journal of Comparative Physiology and Ecology 4:* 113.

21. CANNIBALISM IN THE STAR TORTOISE *GEOCHELONE ELEGANS*

Tortoises in general are herbivorous, though there are odd records of their picking up animal material. Whitaker (*JBNHS 71(1):* 147-148) reports a star tortoise *Geochelone elegans* feeding on a dead mouse. Das (INDIAN TURTLES: A FIELD GUIDE, 1985) has mentioned that star tortoises sometimes eat snails, bird droppings and carrion.

From 1960 to 1975, I used to keep large numbers of star tortoises of different sizes for export. In 1969 it was observed that one male, believed to be about 15 years of age, was very vicious and attacked others. One day a small, three to four year old tortoise was found dead with its head eaten. On each of the following two days, one more tortoise was found dead. All three tortoises had lost only their heads. Shrews sometimes kill tortoises, and on the fourth day a careful watch was kept. It was observed that the old male attacked the smaller tortoises (all 3-5 years old). In all four cases only the head was eaten; the legs were retracted and uninjured.

Cannibalism in turtles and tortoises is apparently rare. In the predominantly herbivorous tortoises this phenomenon is especially interesting.

October 15, 1990 P.W. SOMAN

22. THE FRESHWATER TURTLE FAUNA OF EASTERN RAJASTHAN

(*With a text-figure*)

The present paper describes the freshwater turtle fauna of eastern Rajasthan, particularly of the rivers Banganga and Gambir, the water source for the Keoladeo National Park.

METHODOLOGY

The Banganga and Gambir river systems extend from the north of Jaipur in the west to the north-east of Dholpur in the east. Both rivers are non-perennial. The Keoladeo National Park which lies in their flood plain receives water from them during the rainy season.

The pools along the course of the rivers, associated reservoirs, and nearby village ponds were surveyed for turtles. Fish nets were used to collect turtles, and turtles were also caught by hand from shallow water. Wetland areas which had gone dry were also surveyed and shells collected.

The nomenclature followed is that of Iverson (1986). Most of the survey sites were covered during the dry season from May to July 1989. The Keoladeo National Park was surveyed from January 1988 to December 1988.

RESULTS AND DISCUSSION

A total of 25 water areas were surveyed (Fig. 1), which include 5 sites in Banganga, 17 in Gambir and 2 in

TABLE 1
TURTLE RECORDS FROM THE RIVERS YAMUNA AND GAMBIR

Species	Yamuna (Moll 1984)	Gambir
Kachuga tentoria	recorded	recorded
Kachuga tecta	not recorded	recorded
Kachuga kachuga	recorded	not recorded
Kachuga dhongoka	recorded	recorded
Hardella thurjii	not recorded	recorded
Lissemys punctata	recorded	recorded
Trionyx gangeticus	recorded	recorded

Chambal. The survey covered 14 reservoirs, five pools along the course of the river and four flowing sectors of the rivers. More than half the survey sites were commercial fishing centres. The Keoladeo National Park was also extensively covered.

Altogether 8 species of turtles were recorded during the surveys: five hard shells and the remaining soft shells. At no collection site except at the Keoladeo National Park were more than 4 species seen.

RiverGambir: Six species were recorded: pink-ringed tent turtle *Kachuga tentoria circumdata*, Indian roofed turtle *Kachuga tecta*, dhond roofed turtle *Kachuga dhongoka* and brahminy river turtle *Hardella thurjii*, and two soft-shells, namely the flapshell turtle *Lissemys punctata* and Indian soft-shell turtle *Trionyx gangeticus*.

RiverBanganga: Only three species, namely *Kachuga tecta, Lissemys punctata* and *Trionyx gangeticus* were obtained.

The Banganga has less water than the Gambir and is not connected to any major perennial rivers. On the other hand, the Gambir river system has a perennial tributary, Parvathi, and is linked to the river Yamuna. This diversity of the Gambir system might contribute to its comparatively rich turtle fauna.

Kachuga tentoria was absent in the non-perennial Banganga and it seems that there is a sharp difference in the distribution of the two closely related species, namely *Kachuga tentoria* and *K. tecta*. The former primarily occupies river habitats (6 out of 7 in the present survey were in the river or perennial water bodies connected with it),

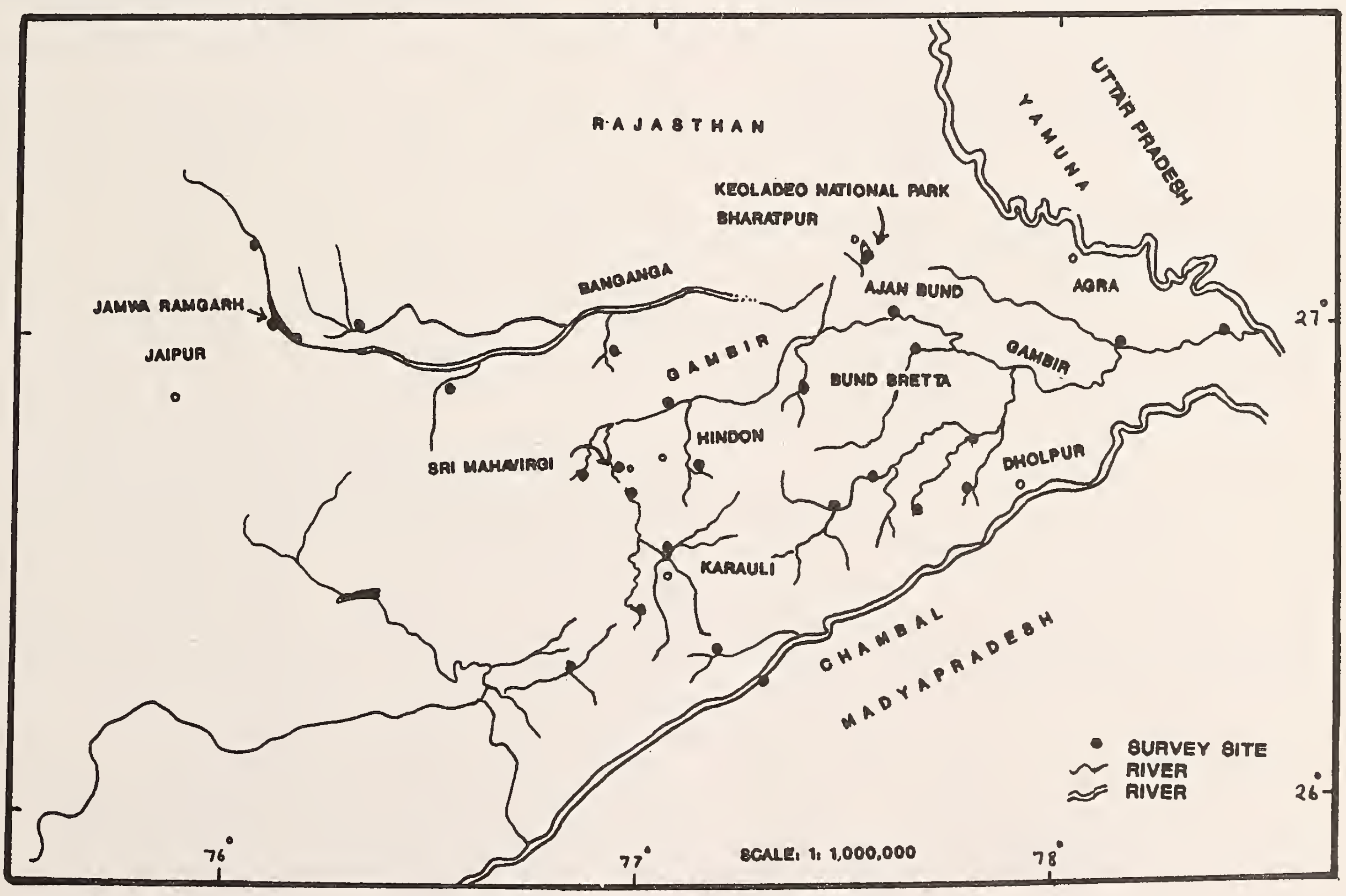


Fig. 1. Banganga and Gambir river systems

TABLE 2
STATUS OF TURTLES IN THE BANGANGA AND GAMBIR RIVERS

Species	No. of turtles (both live & dead) recorded		
	River Gambir	River Banganga	Keoladeo N. Park[1]
Kachuga tentoria	65*	0	1
Kachuga tecta	9	19*	39
Kachuga dhongoka	1	0	0
Hardella thurjii	1	0	499*
Geoclemys hamiltonii	0	0	12
Lissemys punctata	26*	5	1074*
Trionyx gangeticus	45*	95*	174*
Trionyx hurum	0	0	6
No. of sites surveyed	17	5	–

[1]Vijayan (1988) *Common species

whereas the latter is restricted to isolated water bodies.

The area near the confluence of the rivers Gambir and Yamuna had been surveyed earlier by Moll (1984), who recorded 5 species (Table 1). Among these, the painted roofed turtle *Kachuga kachuga* is the only species not seen in the Gambir during the present survey. However, two hard shells, *Kachuga tecta* and *Hardella thurjii* were recorded only from the Gambir.

Keoladeo National Park: In all 7 freshwater turtles were recorded from Keoladeo National Park (4 hard shells and 3 soft-shells). Except two species, namely the spotted pond turtle *Geoclemys hamiltonii* and the Indian peacock soft-shell turtle *Trionyx hurum*, all the other species were recorded in the river systems. *Kachuga dhongoka*, a common species in the Gambir river, was not seen in the Keoladeo National Park.

Status of turtles in the Banganga and Gambir river systems: Among the 8 species recorded, five are common in one or more areas of the system (Table 2). *Lissemys punctata* and *Trionyx gangeticus* were seen at most of the sites, and were common at many sites. *Hardella thurjii* is common only in Keoladeo National Park, whereas the closely related *Kachuga tentoria* and *Kachuga tecta* are common in the Gambir and Banganga respectively.

During the study period specimens of *Lissemys punctata* with colour pattern distinctly different from that in the normal Indo-Gangetic flapshell turtle *Lissemys punctata andersoni* were recorded at two sites near Sri Mahavirji, about 100 km from Bharatpur (Fig. 1). Ten live specimens were collected and compared with the Indo-Gangetic subspecies (Table 3). The black lines on the head and the plain or strikingly patterned carapace (Das 1985) are characteristics of the peninsular subspecies *Lissemys punctata punctata*. The presence of yellow markings on the carapace is the feature seen only in the Indo-Gangetic flapshell turtle (Webb 1980). This may be an intermediate form, as it shows the characters of both subspecies. A detailed study is required to confirm the identity of this turtle.

Locality records of rare turtles: *Geoclemys hamiltonii* and *Trionyx hurum* are rare and information on their distribution is scanty. In recent years *Geoclemys hamiltonii* has been recorded in Assam (Vijaya 1983), north Bihar (Moll and Vijaya 1986), Lucknow (Pai and Basu 1988) and Taunsa Barrage in Pakistan (Scott and Poole 1989).

Trionyx hurum, which was believed to be distributed only in the lower reaches of the Ganga and Brahmaputra, has been reported from other parts of India (Varghese and Tonapi 1986, Pai and Basu 1988, Das 1987, Bhupathy and Ajith Kumar 1989).

River Chambal : Seven species were recorded from the tri-state Chambal National Park (Rao 1986). Two species, namely *Kachuga kachuga* and the narrowheaded soft-shell turtle *Chitra indica*, could not be located in the areas surveyed. *Kachuga tecta* was not recorded in the Chambal even though it is common in some of the nearby water bodies.

SUMMARY AND CONCLUSIONS

The total freshwater turtle fauna of eastern Rajasthan including the records from the river Chambal and Keoladeo National Park goes up to 10 species (Table 4). Of these, six species are hard shells and the remaining four soft-shells. Three species, namely *Kachuga dhongoka*, *Kachuga kachuga* and *Chitra indica* were seen only in rivers, while two species, namely *Geoclemys hamiltonii* and *Trionyx hurum* were seen in small numbers only in the Keoladeo National Park.

In addition, the Indian star tortoise *Geochelone elegans* has been recorded from the Sariska Tiger Reserve and elsewhere in Rajasthan (Biswas and Sanyal 1977, Frazier 1989). The chelonian fauna of Rajasthan is, therefore, of 11 species.

TABLE 3
COMPARISON OF INDO-GANGETIC FLAP-SHELL TURTLE WITH THE SRI MAHAVIRJI TYPE

Indo-Gangetic subspecies *Lissemys punctata andersoni*	Flap-shell from Sri Mahavirji area
1. Head	
Olive green with yellow spots and blotches.	Olive green with black streaks. Yellow spots and blotches absent. Prominent streaks (lines) behind the eyes, between the eyes, and lateral to the eyes on either side.
2. Carapace	
Anterior margin of the carapace (above the foreleg opening) uniformly yellow in colour.	Distinctly patterned with minute yellow and olive green spots.
Distinct yellow spots of various size on the carapace. Spots rarely absent.	Varied in pattern: no spots; very faded spots with black mar-

TABLE 4
TURTLE FAUNA OF RAJASTHAN

Name of the turtle	River Gambir	River Banganga	River Chambal*	Keoladeo N. Park
Pinkringed tent turtle *Kachuga tentoria*	+	–	+	+
Indian roofed turtle *Kachuga tecta*	+	+	–	+
Dhond roofed turtle *Kachuga dhongoka*	+	–	+	–
Painted roofed turtle *Kachuga kachuga*	–	–	+	–
Brahminy river turtle *Hardella thurjii*	+	–	+	+
Spotted pond turtle *Geoclemys hamiltonii*	–	–	–	+
Flapshell turtle *Lissemys punctata*	+	+	+	+
Indian softshell turtle *Trionyx gangeticus*	+	+	+	+
Indian peacock softshell turtle *Trionyx hurum*	–	–	–	+
Narrowheaded softshell turtle *Chitra indica*	–	–	+	–

+ Recorded – Not recorded * Rao (1986)

ACKNOWLEDGEMENTS

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We are grateful to the Rajasthan Fisheries and Forest Department officials for help and co-operation during the survey. We are thankful to J.C. Daniel, Curator, Bombay Natural History Society, for encouragement and suggestions on the unusual flapshells from the Sri Mahavirji area. C.R. Ajith Kumar, Jr. Scientist of the BNHS Ecological Research Centre who was on a fish survey in the Banganga and Gambir river system, helped in the survey and in the preparation of the map.

S. BHUPATHY
V.S. VIJAYAN

July 3, 1990

REFERENCES

BISWAS, S. & SANYAL, D.P. (1977): Fauna of Rajasthan, India, Part: Reptilia. *Rec. Zool. Surv. India 73:* 247-269.

BHUPATHY, S. & AJITH KUMAR, C.R. (1988): On the identity and occurrence of the peacock soft-shell (*Trionyx hurum* Gray) in Rajasthan. *J. Bombay nat. Hist. Soc. 85 (3):* 624.

DANIEL, J.C. (1983): The Book of Indian Reptiles. Bombay Natural History Society, Bombay.

DAS, I. (1985): Indian turtles: a field guide. WWF, Calcutta.

DAS, I. (1987): New locality record for the Indian peacock softshell turtle. *J. Bombay nat. Hist. Soc. 84(3):* 691-692.

FRAZIER, J. (1989): Have you seen the star of India? *Hornbill 1989 (2):* 3-6.

IVERSON, J.B. (1986): Checklist with distribution maps of the turtles of the world. Paust Printing, Richmond.

MOLL, E.O. (1984): Freshwater turtles in India: their status, conservation and management. *Hamadryad 9(3):* 9-17.

MOLL, E.O. & VIJAYA, J. (1986): Distributional records for some Indian turtles. *J. Bombay nat. Hist. Soc. 83(1):* 57-62.

PAI, A. & BASU, D. (1988): Turtles of an ancient pilgrimage tank in North India with notes on the distribution of the Peacock Soft- shell Turtle (*Trionyx hurum*). *Hamadryad 13(2):* 12-15.

PRITCHARD, P.C.H. (1979): Encyclopedia of Turtles. TFH Publications, New Jersey.

RAO, R.J. (1986): Research on wildlife in National Chambal Sanctuary and Ghana Bird Sanctuary. Review Report, Research Centre of Wildlife Institute of India, National Chambal Sanctuary, Deori, Morena.

SCOTT, D.A. & POOLE, C.M. (1989): A status overview of Asian Wetlands. AWB, Kuala Lumpur, Malayasia. No. 53.

SMITH, M.A. (1933): Fauna of British India inlcuding Ceylon and Burma. Vol. I, Loricata, Testudines. Taylor & Francis, London.

VIJAYA, J. (1983): Range extension for the spotted pond turtle, *Geoclemys hamiltoni*. *Hamadryad 8 (2):* 20.

VIJAYAN, V.S. (1988): Keoladeo National Park Ecology Study, Annual Report 1987. Bombay Natural History Society, Bombay.

VARGHESE, G. & TONAPI, G.T. (1986): Observations on the identity of some Indian freshwater turtles and their feeding habits. *Biol. Conserv. 37:* 87-92.

WEBB (1980): The identity of *Testudo punctata* Lacepede, 1788 (Testudines. Trionychidae). *Bull. Mus. natn. Hist. nat.*, Paris, Ser. 4:2 (Sec. A, no. 2): 547-557.

23. INTERACTION BETWEEN COMMON SKINK *MABUYA CARINATA* AND JUNGLE CROW *CORVUS MACRORHYNCHOS*

One morning during September 1990 we observed an interesting interaction between a common skink *Mabuya carinata* and a jungle crow *Corvus macrorhynchos* over a food item. At about 1000 hrs we heard the frantic cries of a frog in our backyard at our residence in Malaparamba in Calicut. We came out for a closer look and found a skink holding a frog in its mouth. The skink had gripped the frog in the abdominal region and was apparently having some difficulty in swallowing it. The frog did not stop its cries and even after about 10 minutes the skink was unable to swallow it. We knew that we were witnessing an unusual incident since the common skink more or less exclusively feeds on insects, and only occasionally takes small vertebrates (BOOK OF INDIAN REPTILES, Daniel, J.C. 1983). But a bigger surprise was in store for us. A jungle crow was soon attracted by the frog's cries and alighted on the compound wall nearby and observed the proceedings attentively. After some time the crow hopped down and before the skink could react, snatched the frog and flew away.

S. DEVASAHAYAM
October 22, 1990 ANITA DEVASAHAYAM

24. SIGHTING OF THE ARBOREAL SKINK *DASIA HALIANA* AT MUNDANTHURAI WILDLIFE SANCTUARY, TAMIL NADU

The arboreal skink *Dasia haliana* (Nevill) is apparently rare. The species was recorded very recently on the banks of the river Tambiraparani in Mundanthurai Wildlife Sanctuary, Tamil Nadu (Joshua and Sekar 1985). Johnsingh (1986) also recorded the species in the same area.

At noon on 18 May 1990, during my visit to the gallery forest along the banks of the Servalar river in the Mundanthurai Wildlife Sanctuary, one of the guides who accompanied me spotted an arboreal skink. The reptile was moving very slowly in the forest canopy. When the guide tried to collect the skink for closer observation, it slid into a hole in a dead limb of a tree entangled in the canopy. The dead branch was carefully brought down and the skink taken out. It was released in the same place shortly, after measurements and photographs were taken. The total length, from nose tip to tail tip was 160 mm. Since the skink matched the description given by Smith (1935), the identity was confirmed as *Dasia haliana* (Nevill).

On enquiry, the local guides said that they had come across the skink near the Tambiraparani river and not near Servalar river. According to them the skink can usually be seen shortly after rains, which is when many reptiles are active.

Though the skink has been seen in the same general area within Mundanthurai Wildlife Sanctuary the present sighting is of interest as the animal was sighted on the banks of the Servalar river near the dormitory maintained by the Forest Department, nearly 0.5 km from the junction of the Tambiraparani and Servalar towards the Servalar dam. The claim of the local guides that the skink is known to occur over a much wider area needs to be investigated.

I wish to thank the local guides who accompanied on the trip and Dr S. Subramanya, University of Agricultural Sciences, Bangalore, for helping in preparing the text and for constant encouragement.

August 21, 1990 S. KARTHIKEYAN

REFERENCES

JOHNSINGH, A.J.T. (1986): The Living Hills. *Sanctuary Asia 6(2).*

JOSHUA, J. & SEKAR, A.G. (1985): Range Extension of the skink *Dasia haliana* (Nevill, 1987): *J. Bombay nat. Hist. Soc. 82: 423.*

SMITH, M.A. (1935): Fauna of British India, Reptilia and Amphibia, vol. II. pp. 440.

25. FOOD HABITS OF THE COMMON RAT-SNAKE *PTYAS MUCOSUS* LINN.

The dhaman or common rat-snake *Ptyas mucosus* Linn. is widely distributed in India. It is diurnal and commonly seen close to human habitation. Recorded food items are geckos, toads, frogs, young pond turtles, nestling birds, skinks, agamid lizards, bats and snakes (Daniel 1983).

On the way to Sariska Tiger Reserve from Delhi in November 1990, we found a rat-snake run over by a vehicle, close to Firozpur (Haryana). Head to tail tip length and body weight were 202 cm and 1500 g respectively. Whitaker (*JBNHS 66(1):* 185-186) reported that adults averaged 180 to 210 cm in length with a maximum of 250 cm from a locality near Bombay. Daniel (THE BOOK OF INDIAN REPTILES, 1983) reports that most adult specimens are between 165 cm and 200 cm with a maximum of 352 cm. Examination of stomach contents revealed that the snake had swallowed two chicks of the blue-rock pigeon *Columba livia* weighing 43.3 and 49.0 gms and one soft-furred field rat *Rattus meltada* Gray weighing 55.5 gms, equivalent to 10% of the snake's body weight (Table 1).

December 7, 1990 S.P. GOYAL

TABLE 1
FOOD ITEMS OF RAT-SNAKE *Ptyas mucosus*

Food items	Characteristics
1. Two chicks of blue-rock pigeon *Columba livia*	Weight: 43.3 g and 49.0 g
2. Soft-furred field rat *Rattus meltada*	Weight: 55.5 g, male. External body measurements: Head and body: 129 mm, tail: 104 mm ear 21 mm, hind foot: 24 mm.

26. RANGE EXTENSION OF DUMERIL'S BLACKHEADED SNAKE *SIBYNOPHIS SUBPUNCTATUS* (DUM. & BIBR.)

On 15 March 1987, at Point Calimere, Thanjavur district, Tamil Nadu, a southern crow-pheasant *Centropus sinensis parroti* was noticed carrying a snake. Accidentally the snake slipped out of the crow-pheasant's beak and we collected it before it was picked up by the bird. The snake was later measured and identified as Dumeril's blackheaded snake *Sibynophis subpunctatus*. The snake was 40 cm in length. In current literature the distribution is given as south-west, central and north-east India (COMMON INDIAN SNAKES, Whitaker, R. 1978). This record indicates that its distribution ranges up to south-east India.

We are thankful to A. Gnanasekar of the Bombay Natural History Society, for his help in identifying the snake.

V. NATARAJAN
May 6, 1990 S. ALAGAR RAJAN

27. EXTENSION OF RANGE OF THE BLACK COBRA *NAJA NAJA OXIANA*

On 10 December 1990 at about 1000 hrs one of our bird trappers who was trapping raptors in the scrubland around the Dhandh, in Kutch district, Gujarat, rushed back to camp to inform us that a black cobra *Naja naja* had attacked another snake and was devouring it. We went to the site immediately but the cobra had already eaten the snake and withdrawn into a hole. On being disturbed, the cobra rushed out of its hole and regurgitated its freshly swallowed prey.

The cobra lacked the ocellations and was uniformly black. Its lack of patterns was clearly visible as it hissed violently and spread its hood. It soon disappeared into a nearby hole, leaving its regurgitated prey behind. We collected the specimen and identified it as a saw scaled viper *Echis carinatus*. Its biometrics were as follows:

Total body length 780.5 mm; tail length 80 mm; weight 305 g.

According to Smith (FAUNA OF BRITISH INDIA, 1843) the black cobra occurs in Punjab and Kashmir. Whitaker (COMMON INDIAN SNAKES, 1978) mentions it as occurring in north-west India. The present record of the black cobra in Chhari Dhandh in Kutch extends the range of this subspecies.

S. ASAD AKHTAR
November 16, 1990 J.K. TIWARI

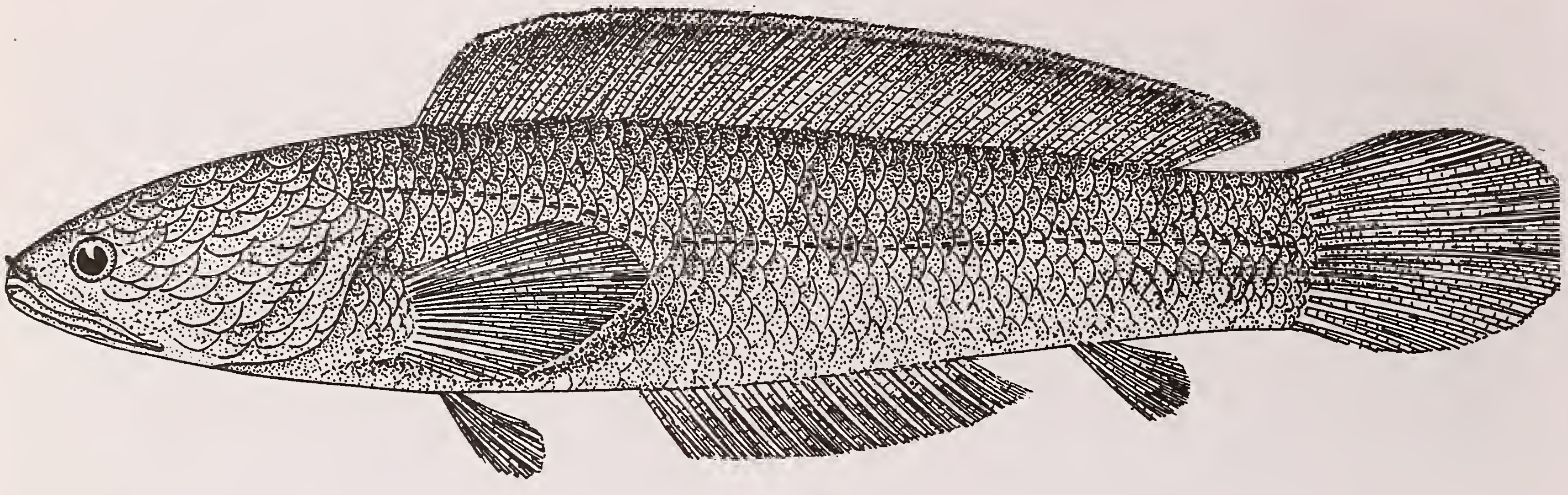

Fig. 1. An abnormal specimen of *Channa orientalis*

28. AN ABNORMAL SPECIMEN OF *CHANNA ORIENTALIS* SCHNEIDER (PISCES : CHANNIDA) FROM TRIPURA

(With a text-figure)

No species under the genus *Channa* of the Channidae family or even the order Channiformes, or from any freshwater fish family, is so far known with two anal fins or an anal fin in two parts. During taxonomic studies of the fish fauna of Tripura, north-east India, an interesting specimen of the genus *Channa* was found. On examination it proved to be an abnormal specimen of *C. orientalis*, having two anal fins or, rather, a single fin separated by 5 to 6 scales from each other. Anal fin with two parts, first part with 15 rays and second part with 5 rays.

Material examined: 1 ex., 186 mm. TL.; Reg. No. Zoological Survey of India, Calcutta FF 2665; Deo river, Kanchanpur, north Tripura; R.P. Barman and party; 21 October 1989.

We thank Dr. S.M. Jairajpuri, Director, and Dr. A.K.Ghosh, Joint Director-in-charge of Fish Division, Zoological Survey of India, Calcutta, for facilities and encouragement, H.J. Roy, Superintendent of Fisheries, Kumarghat, north Tripura for assistance during the period of the survey, D. Pyne and B. Mondal, departmental artists for the drawing.

R.P. BARMAN
R.S. BARMAN

September 3, 1990

29. FIRST RECORD OF THE BELONTID FISH *MACROPODUS CUPANUS* VALENCIENNES FROM PUNE, MAHARASHTRA

(With a text-figure)

While collecting shrimp in the shallow waters of the river Mutha in a stretch with plenty of aquatic vegetation, a small fish was collected near Vitthalwadi, Maharashtra, in January 1990. The fish looked different from those usually caught. It was brought alive and kept in the laboratory for a week. The colour was greenish, being slightly darker near the dorsal fin. The first ray of each ventral fin was produced into a long scarlet red filament that nearly reached up to the anterior one-third of the anal fin. The soft portion of the dorsal fin was dotted with small black spots, while the distal portion of the anal fin in the posterior one-third showed a large, conspicuous black mark. The caudal fin was lanceolate and was barred with distinct black spots. Many of these characters can be seen even in alcohol preserved specimens (Fig. 1). The total length of the fish was 45 mm. From Day's book it was identified as *Polyacanthus cupanus*. Later, after its death, the fish was properly preserved and examined carefully. It matched well with the description given by Day (1865, 1889). The fish is now named *Macropodus cupanus* Valenciennes, as given by Jayaram (1981), who also confirmed our identification.

A search of the literature on fishes of Pune (formerly Poona) indicated that *Macropodus* has not so far been recorded from Pune or nearby areas (Fraser 1942 a, b, Hora and Misra 1942, Suter 1943, Tonapi and Mulherkar 1963).

Day (1865) cited the habitat of this fish as "fresh waters of Malabar and Coromandel." Later (1889) he commented that the fish is "often found in ditches, paddy fields

Fig. 1. *Macropodus cupanus* (scale bar in mm)

and shallow waters, generally within or not far removed from tidal influence". He also mentioned that it was found "...... in the Bhavani at Mettupalaiyam and also along the base of the ghats in Canara. It lurks under stones, or among weeds, and becomes very tame in the aquarium. It grows to about 3 inches in length." He had described the colour of the fish as rifle- green.

Jayaram (1981) included this fish under family Belontidae and subfamily Macropodinae and marked it as the species visiting freshwater; the distribution is given as "..... Kerala, Coromandel and Western Ghats". *Macropodus* has also been reported from brackish water ponds of Goa by Tilak (1973) with a comment on distribution as "..... found in pools and ponds along the coasts of India."

Jones (1940) gave an interesting account of the breeding habits and early embryonic development of this fish. He found the fish to be: common in tanks, lakes and ditches; capable of breathing atmospheric air; capable of burrowing in mud when frightened; an important mosquito larvivore and one in which larvae possess cement glands.

This report is based on a single specimen, collected alive from the river. An attempt is being made to locate the population around this area.

We are grateful to Dr. K.C. Jayaram for confirming our identification, and for commenting on the manuscript. Thanks are also due to Dr. G.M. Yazdani (OIC, Z.S.I., Pune) for helpful discussions and for providing useful literature, and to the authorities of Modern College for providing facilities and for encouragement.

H.V. GHATE
December 4, 1990 G.K.WAGH

REFERENCES

DAY, F. (1865): The Fishes of Malabar. Indian Reprint 1981, by Bishen Singh Mahendra Pal Singh, Dehra Dun.

DAY, F. (1889): The Fauna of British India, including Ceylon and Burma. Fishes Vol II, Indian Reprint 1989, by Today and Tomorrow's Printers and Publishers, New Delhi.

FRASER, A.G.L. (1942 a): Fish of Poona, Part I. *J. Bombay nat. Hist. Soc. 43:* 79-91.

FRASER, A.G.L. (1942 b): Fish of Poona, Part III. *J. Bombay nat. Hist. Soc. 43:* 452-454.

HORA, S.L. & MISRA, K.S. (1942): Fish of Poona, Part II. *J. Bombay nat. Hist. Soc. 43:* 218-225.

JAYARAM, K.C. (1981): The Freshwater Fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka - a Handbook. Z.S.I. Calcutta.

JONES, S. (1940): Notes on breeding habits habits and early development of *Macropodus cupanus* (Cuv. & Val.) with special reference to the cement gland of early larva. *Rec. India Mus. 32:* 269 -276.

SUTER, M. (1943): New records of fish from Poona. *J. Bombay nat Hist. Soc. 44:* 408-414.

TILAK, R. (1973): A study of freshwater and estuarine fishes of Goa, 2. *Rec. Zool. Surv. India 67:* 87-120.

TONAPI, G.T. & MULHERKAR, L. (1963): Notes on freshwater fauna of Poona - Fishes. *Proc. Indian Acad Sci. 38:* 187-197.

30. DISTRIBUTION OF THE AMPHIBIAN FAUNA OF INDIA

The amphibian fauna of India and their distribution have been described by Inger and Dutta (1986). Chanda and Ghosh (1988) added a few more species not listed by Inger and Dutta. The collection data of amphibian fauna in BNHS collection shows that some of the species have been collected from states other than those mentioned by Inger and Dutta, and Chanda and Ghosh. In this note the extension of range for some species, not reported earlier, is given.

November 16, 1990 A.G. SEKAR

REFERENCES

CHANDA, S.K. & GHOSH, A.K. (1988): Addenda to the Amphibian fauna of India. *J. Bombay nat. Hist. Soc. 85:* 626-627.

DANIEL, J.C. & VERMA, K.K. (1963): Occurrence of the Ceylon Kaloula, *Kaloula pulchra taprobanica* HW. Parker (Fami-

ly: Microhylidae) at Jagdalpur, Bastar District, M.P. *J. Bombay nat. Hist. Soc. 60:* 744-745.

INGER, R.F. & DUTTA, S.K. (1986): An overview of the Amphibian fauna of India. *J. Bombay nat. Hist. Soc. 83 (Supplement)*: 135-146.

TILAK, R & RAY, P. (1990): Range extension and notes on *Rana erythraea* (Schlegel, 1837) (Anura:Ranidae) from Dudhwa National Park, Uttar Praesh.

Species	Known occurrence (Inger & Dutta 1986)	Extension of known occurrence
ANURA		
BUFONIDAE		
1. *Bufo himalayana* Gunther, 1894	Arunachal Pradesh, Meghalaya, Sikkim, West Bengal	Uttar Pradesh
2. *Bufo microtympanum* Boulenger, 1882	Kerala	Tamil Nadu, Maharashtra
3. *Bufo stomaticus* Lutken, 1862	Assam, Bihar, Himachal Pradesh, Karnataka, Jammu & Kashmir, Maharashtra, Orissa, West Bengal	Andhra Pradesh, Gujarat, Punjab, Rajasthan, Uttar Pradesh
MICROHYLIDAE		
4. *Kaloula pulchra* Gray, 1831	Assam, Karnataka, West Bengal	Tamil Nadu, Kerala, Madhya Pradesh (Daniel &Verma 1963)
5. *Microhyla rubra* (Jerdon, 1854)	Assam, Kerala, Tamil Nadu, West Bengal	Andhra Pradesh, Karnataka
6. *Ramanella montana* (Jerdon, 1854)	Kerala, Maharashtra	Goa, Gujarat, Karnataka
7. *Ramanella variegata* (Stoliczka, 1872)	Karnataka, Kerala, Madhya Pradesh, Orissa, Tamil Nadu, West Bengal	Maharashtra
8. *Uperodon globulosum* (Gunther, 1864)	Assam, Bihar, Karnataka, Madhya Pradesh, Maharashtra, Orissa, West Bengal	Goa, Gujarat
9. *Uperodon systoma* (Schneider, 1799)	Karnataka, Kerala, Orissa, Himachal Pradesh, Tamil Nadu, Uttar Pradesh, West Bengal	Andhra Pradesh
RANIDAE		
10. *Micrixalus fuscus* (Boulenger, 1882)	Kerala	Tamil Nadu
11. *Nyctibatrachus humayuni* (Bhaduri & Kripalani, 1955)	Maharashtra	Goa
12. *Nyctibatrachus major* (Boulenger, 1882)	Kerala	Tamil Nadu
13. *Rana beddomii* (Gunther, 1875)	Kerala, Maharashtra	Karnataka, Tamil Nadu
14. *Rana brevipalmata* Peters, 1871	Kerala, Tamil Nadu	Karnataka
15. *Rana curtipes* Jerdon, 1853	Karnataka, Kerala	Tamil Nadu
16. *Rana diplosticta* (Gunther, 1875)	Kerala	Tamil Nadu
17. *Rana erythraea* (Schlegel, 1837)	Assam, Orissa, Meghalaya (according to Chanda &Ghosh 1988)	Nicobar Islands, Uttar Pradesh (Tilak & Ray, 1990)
18. *Rana hexadactyla* Lesson, 1834	Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Rajasthan (?), Tamil Nadu, West Bengal	Goa

Species	Known occurrence (Inger &Dutta 1986)	Extension of known occurrence
19. *Rana keralensis* Dubois, 1980	Kerala	Goa, Karnataka, Tamil Nadu
20. *Rana leithii* Boulenger,1888	Gujarat, Kerala, Madhya Pradesh, Maharashtra	Tamil Nadu
21. *Rana leptodactyla* Boulenger, 1882	Kerala	Tamil Nadu
22. *Rana malabarica* Tchudi, 1838	Kerala, Madhya Pradesh, Maharashtra	Goa, Karnataka
23. *Rana semipalmata* Boulenger, 1882	Kerala	Tamil Nadu
24. *Rana syhadrensis* Annandale, 1919	Maharashtra, Orissa	Goa
25. *Rana temporalis* (Gunther, 1864)	Karnataka, Kerala, Maharashtra	Tamil Nadu
26. *Tomopterna breviceps* (Schneider, 1799)	Bihar, Himachal Pradesh, Kerala, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal.	Andhra Pradesh, Goa, Gujarat, Maharashtra, Madhya Pradesh
27. *Tomopterna rufescens* (Jerdon, 1854)	Kerala, Maharashtra	Goa, Karnataka
RHACOPHORIDAE		
28. *Philautus bombayensis* (Annandale, 1919)	Maharashtra	Goa
29. *Philautus chalazodes* (Gunther, 1865)	Kerala	Karnataka, Tamil Nadu
30. *Philautus glandulosus* (Jerdon, 1853)	Kerala, Maharashtra	Tamil Nadu
31. *Philautus leucorhinus* (Lichtenstein & Martens, 1856)	Kerala	Goa, Karnataka
32. *Philautus variabilis* (Gunther, 1858)	Andhra Pradesh, Kerala	Tamil Nadu, Karnataka
33. *Rhacophorus malabaricus* Jerdon, 1870	Karnataka, Kerala	Goa, Tamil Nadu
GYMNOPHIONA ICHTHYOPHIDAE		
34. *Ichthyophis sikkimensis* Taylor, 1960	Sikkim, West Bengal	Kerala

31. OCCURRENCE OF THE MALABAR TORRENT TOAD *ANSONIA ORNATA* GUNTHER IN SOUTH KANARA, KARNATAKA

The Malabar torrent toad *Ansonia ornata* is one of the little known anurans in India. The only known specimens of this brightly coloured toad are probably from the Brahmagiri hills in Coorg (Daniel, J.C., *JBNHS 60:* 415-438). I recently found quite a few individuals of this toad at Neria, a small hill station off the well known Dharmastala in the South Kanara district. Neria, despite its vast stretches of coffee, rubber and cardomom estates, still retains a fair amount of tall rainforests along the slopes and higher reaches. It receives an annual rainfall of 4500-6000 mm, with only four dry months (December- March). The terrain is rugged with several narrow torrential streams that were flowing fast especially during October-November (1990) when I was there. the slimy rocks were

the microhabitats for several species of frogs.

During the short stay (28 October to 3 November 1990) I came across at least 10 of these torrent toads at an altitude of *c*. 600 m. There were more juveniles and these were often far from water in the wet litter. The adults were on wet rocks just above water in the fast flowing rivers. There were freshly metamorphosing toads with tails on the rocks above water and also tadpoles clinging to the rocks in the torrents of at least one of the rivers visited.

The Malabar torrent toad is quite remarkable for its slender build and striking colour. For possible benefits of camouflage, the most striking colour pattern of bright yellow and red are restricted to the underside of the toad. The adults noted were 2.8-3.2 cm in length (snout-vent), jet black above with yellow spots on the limbs and belly. The belly is brick red, the red being a circular patch. The number of yellow spots on this red belly is variable. I found adults with 1, 2, 3 and 5 spots on the belly. The juveniles lack the yellow spots but have a red belly patch, though less clearly defined. Dorsally they are more marbled with olive. The freshly metamorphosing toads are more olivaceous with fine black marbling. The tadpoles are black, stocky and comparatively short-tailed and show remarkable capacity to cling to the slimy rocks under water. One tadpole was observed scaling a rock to get to a small puddle of rain water.

I was not able to observe anything on the toad's food and behaviour in the field. One adult that is in a small terrarium at Bangalore prefers to sit on top of a rock provided, in an upright position, displaying the bright colours on the belly and limbs. It has not yet started accepting food.

November 16, 1990 RANJIT DANIELS

32. ON THE MIGRATION OF THE LARGE CABBAGE WHITE BUTTERFLY *PIERIS BRASSICAE* IN KASHMIR

(With a text-figure)

The large cabbage white *Pieris brassicae* is common in the western Himalayas. It is an altitudinal migrant, descending to plains and lower hills in winter and migrating back in summer (Wynter-Blyth 1957). The mass movements of this species are conspicuous and well documented in Europe (Williams 1930), but the published data from India is fragmentary. The following is one such instance of migration of this species.

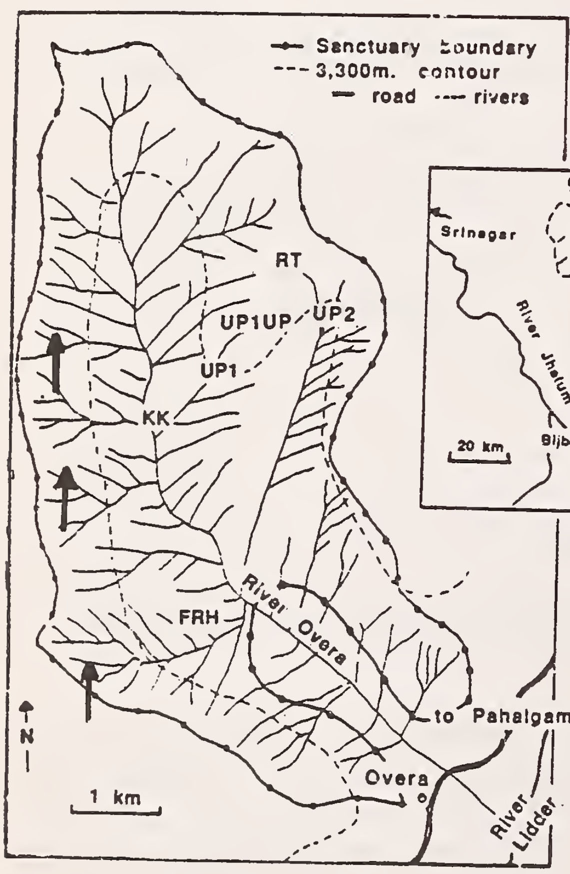

Fig. 1. Overa Wildlife Sanctuary. Dotted line is the approximate 3300 m contour. Arrow shows direction of butterfly migration.

The location was the western ridge of the Overa Wildlife Sanctuary, Kashmir, the altitude being 3800 m. On one side the ridge falls sharply towards Liddar valley and on the other side the slope is gradual towards the Jhelum valley. The top of the ridge is narrow at some places broadening to grassy meadows strewn with alpine flowers. The ridge is flanked by stands of silver birch (*Betula* sp.), sparser near the top.

The mass movement of butterflies was first noted on the morning of 28 May 1988. The weather was calm, clear and sunny, and remained thus throughout. It continued till afternoon of the next day. Thereafter it became cloudy, overcast with a hint of rain. As we became aware of the sudden influx of butterflies it became apparent that a migration was in progress. The butterflies were coming up the ridge in an incessant stream. The flight was rapid in one direction and the butterflies were flying on, hardly resting. They kept mostly to the crest of the ridge, and at the centre the air appeared to be thick with butterflies, flying from ground level almost till the eye could reach. So striking and conspicuous was this movement that it was impossible not to notice it. The direction of the flight was from south to north (Fig. 1).

The flight of the butterflies was followed uptil a point where the ridge rises sharply to about 4000 m. Here the butterflies were fluttering up close to the cliff face in

a scrambling flight and disappearing over the top. The flow continued in profusion till afternoon of the next day, then became sparse and irregular. To estimate the total number of butterflies, the number passing through an area 30 m high and 30 m in width were counted at 1140 hrs on 28 May, by using a chronometer. In two minutes, 102 butterflies passed through the segment. The butterflies passing outside this segment were not counted. By a crude estimate, considering that a very negligible portion was flying through the segment, at least 75,000 to 80,000 butterflies passed the camp site in the day and a half. Despite such abundance of cabbage white butterflies and presence of black swift *Apus apus*, hobby *Falco subbuteo*, kestrel *Falco tinnunculus*, predation was not noticed. This butterfly is considered as distasteful.

There are a few reports on migration of *Pieris brassicae*. Hingston (vide Williams 1930) has described the on (*Hydrilla* sp.) was kept in the aquarium to provide substratum for the waterbugs. The snail *Lymnaea luteola* of different size classes were supplied to the bugs as food regularly. The female waterbugs deposited eggs on the back of the males within a few days. Four such egg-bearing males were kept separately, in a plastic container of two litre capacity, at 20°C, 25°C, 30°C, constant temperature grades maintained in different chambers of a BOD incubator and at room temperature (19°C-35°C). The newly hatched nymphs were maintained carefully with the supply of preferred sized *L. luteola* daily, as their food. The experiments were terminated when all the waterbugs (nymphs) metamorphosed into adults. Throughout the experi

Another summer season (May-June 1989) was spent in the same area, but the migration was not noticed. Specimens of *P. brassicae* were collected and added to the BNHS collection. The identification was confirmed by Mr. Naresh Chaturvedi. Thanks are also due to him for help with references.

Similar other records of migration of this species will be worth placing on record so as to eventually plot a definite route/pattern of migration.

October 12, 1989 NITIN JAMDAR

REFERENCES

MAXWELL-LEFROY, H. (1909): Indian insect life. Reprinted by Today and Tommorrow's Publishers, New Delhi.

WILLIAMS, C.B. (1930): The migration of butterflies. Oliver and Boyd, Edinburgh.

FLETCHER, T.B. (1914): Some south Indian insects. Govt. Press, Madras.

WYNTER-BLYTH, M.A. (1957): Butterflies of the Indian region. Bombay Natural History Society, Bombay.

33. INFLUENCE OF TEMPERATURE ON SEX DETERMINATION OF THE WATERBUG *SPHAERODEMA RUSTICUM* FAB.

Though sex determination is a purely genetic mechanism, the influence of environmental factors on the same cannot be ruled out (Conover and Heins 1987, Conover and Kynard 1981, Charnov and ull 1977). Of the environmental factors, temperature seems to be the most important one. It is reported that the sex ratio in a few invertebrates, fishes, alligators and turtles varied widely in response to temperature regime (Conover and Heins 1987, Conover and Kynard 1981, Bull and Vogt 1979, Charnov and Bull 1977). Investigation on this aspect in insects is necessary. We have studied it in the waterbug *Sphaerodema rusticum* Fab. and the results are given below.

A good number of adult waterbugs *S. rusticum* were collected from a pond located in the Ballygunge Science College campus, Calcutta University, Calcutta, and kept in an aquarium measuring 60 x 25 x 45 cm, filled with pond water up to 30 cm height. A considerable amount of aquatic vegetation (*Hydrilla* sp.) was kept in the aquarium to provide substratum for the waterbugs. The snail *Lymnaea luteola* of different size classes were supplied to the bugs as food regularly. The female waterbugs deposited eggs on the back of the males within a few days. Four such egg-bearing males were kept separately, in a plastic container of two litre capacity, at 20°C, 25°C, 30°C, constant temperature grades maintained in different chambers of a BOD incubator and at room temperature (19°C-35°C). The newly hatched nymphs were maintained carefully with the supply of preferred sized *L. luteola* daily, as their food. The experiments were terminated when all the waterbugs (nymphs) metamorphosed into adults. Throughout the experiment strict hygienic conditions were maintained by changing the pond water, by removing the dead snails and waterbugs, if any, by removing the empty shells of *L. luteola* and by changing the plant materials regularly.

The number of newly hatched nymphs, the number of adult waterbugs metamorphosed out of these nymphs, the number of male and female waterbugs in respect of the selected 4 clutches against four different temperature grades have been shown in Table 1. It is evident that the sex ratio at 30°C constant temperature was 1 : 1 (M:F) while at 25°C and 20°C the same was 1 : 2 and 1 : 5.5 respectively.

TABLE 1
EXPERIMENTAL DATA SHOWING SEX RATIO OF *S. rusticum* MAINTAINED AT DIFFERENT TEMPERATURES

Temperature (° C)	Clutch no.	No. of newly hatched nymphs	No. of nymphs metamorphosed into adults	No. of males	No. of females	Sex ratio (M:F)
	1	50	6	0	6	
	2	30	4	1	3	
20	3	12	1	0	1	1:5.5
	4	8	2	1	1	
	Total	100	13	2	11	
	1	50	10	4	6	
	2	25	7	25		
25	3	10	3	1	2	1:2
	4	12	4	1	3	
	Total	97	24	8	16	
	1	40	7	4	3	
	2	30	6	3	3	
30	3	25	7	3	4	1:1
	4	30	8	3	5	
	Total	125	28	13	15	
	1	50	17	8	9	
Room temp.	2	40	11	5	6	1:1
(19-35)	3	30	7	3	4	
	4	25	6	4	2	
	Total	145	41	20	21	

It is established that the metamorphosis and attainment of sexual maturity in animals, especially insects, are regulated by hormones. It is likely that the synthesis of hormone is highly temperature dependent. The quantitative study of the hormones in these insects reared at these temperatures would enable us to throw some light on the role of temperature on the determination of sex in insects. It is apparent that the percentage of females would gradually increase with the lowering of temperature from 30°C to 20 °C.

We thank the Head of the Department of Zoology, Calcutta University, Calcutta, for facilities provided.

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J.K. ROY

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REFERENCES

BULL, J.J. & VOGT, R.C. (1979) : Temperature dependent sex determination in turtles. *Science 206* : 1186-1189.

CHARNOV, L. & BULL, J.A. (1977) : When is sex environmentally determined? *Nature 266:* 828-830.

CONOVER, O.D. & HEINS, W.S. (1987) : Adaptive variation in environmental and genetic sex determination in a fish. *Nature 326:* 496-498.

CONOVER, O.D. & KYNARD, E.B. (1981): Environmental sex determination : Interaction of temperature and genotype in a fish. *Science 213:* 577-579.

34. OCCURRENCE OF BIVALVED GASTROPODS IN THE WEST COAST OF INDIA, ARABIAN SEA

The bivalved gastropods are noteworthy for their anomalous shells. Ever since the discovery of the first living representative of the bivalved gastropods, *Berthelinia limax* from Bison Seto, Inland Sea of Japan by Kawaguti and Baba 1959, establishing its true identity as sacoglossan opisthobranch, many discoveries and descriptions of bivalved gestropods have been published from different parts of the world (Table 1). From Indian

seas, living representatives of the bivalved gastropods have been recorded from Mandapam (Gulf of Mannar) (Prabhakara Rao 1965), Visakhapatanam foreshore (Ganapati and Sarma 1968) on the east coast of India and along the coast of Port Blair, Andaman and Nicobar Islands (Bay of Bengal) (Ganapati and Sarma 1972, Sarma 1975).

While engaged in studies on the phytal faunal associations of foreshore algae off Kovalam beach of Trivandrum on the west coast of India, Arabian sea, two specimens of the bivalved gastropod *Berthelinia* Crosse, were seen among the preserved siphonous green algal samples of *Caulerpa racemosa* C.r. (Forsk) J. Agardh, collected at low water mark. The present find represents the first report of the bivalved gastropods recorded and described from the Arabian Sea.

The two specimens (Figs. 1, 2) measured 1.10 mm and 0.935 mm long, 0.76 mm and 0.701 mm high; 0.526 mm and 0.4425 mm across the paired valves respectively. The shell valves are unequal, unequilateral and ovato-trigonal in outline. The valves are leaf green in colour, covered with a thin transparent periostracum with faint concentric lines of growth. A shining circular adductor muscle impression is seen subcentrally on the shell valves of the two specimens, measuring 0.15 and 0.13 mm in diameter. The protoconchs (Fig. 3) located subcentrally on the left valves are one and one-half whorls, oblique, more discoidal than helicoidal, measuring 0.14 and 0.13 mm high and are closely applied to the dorsal posterior margin of the valves and do not extend on to the right valve.

Inside the shell valves, entirely retracted, lies the animal having a slug-shaped body (Fig. 2). The auriculate rhinophores, neck and foot are uniformly green in colour. Two black eyes are present, one on either side, on an elevation of the neck behind the rhinophores. The oral tentacles are pointed at the corners. The sole of the foot is longitudinally grooved throughout its length.

The present specimens with the whole anterior and dorsal and porterior dorsal margin of the shell forming almost one continuous curve, cannot be identified satisfactorily with any of the bertheliniid species so far described. The detailed description including anatomical observations and comparisons with other known species including naming of the present finding would be published elsewhere. However, a brief comparison of the external shell morphology of the present specimens with that of already described *Berthelinia* is given below for quick field identification.

The specimens were compared with the preserved specimens of *B. (Tamanovalva) babai* (Burn 1965) (= *B. typica*, Burn 1960); *B. fijiensis* (Burn 1966); *Midorigai australis* (Burn 1960) and *B. (Edenttellina) typica* (Gatliff and Gabriel 1911), which were kindly made available by Robert Burn. *B. (E.) typica* and *M. australis* are readily distinguished by the colour patterns of the valve mantles. *B. (E.) typica* has 5-6 more or less horizontal parallel black pigmented lines. *M. australis* has curved radials of white pigment cells on a dark green background and the present specimens are uniformly green.

Berthelinia (Tamanovalva) fijiensis (Burn 1966) differs in having a more abrupt anterior margin, a sharper break or curve between dorsal and anterior margin and true straight margin behind the protoconch.

The almost horizontal protoconchs of one and one-quarter and one and one-half whorls distinguish *B. (T.) chloris* Dall 1898 and *B. (T.) pseudochloris* (Kay 1964), respectively from the present find. The almost oval shell and small hidden nucleus of *B. (T.) limax* (Kawaguti and Baba 1959) separate it from the present findings.

B. (T.) ganapatti Sarma, 1975 differs in having a more abrupt anterior margin and longer, straighter posterior margin with small erect protoconch. The shells of *B. (T.) waltairensis* Sarma, 1975 resemble those of the present specimens but differ in having steep and straight posterior margins.

Associated with the bivalved gastropods inhabiting *C. racemosa* are other sacoglossan opisthobranch gastropods belonging to the genera *Cylindrobulla*, *Lobiger* and *Oxynoe*.

We thank Robert Burn, Honorary Associate in Conchology, National Museum of Victoria, Melbourne, Australia, for making available the specimens of Australian bivalved gastropods for comparative studies; late Prof. Dr. M.V. Ramji, former Head, Department of Science, R.C.E, Bhubaneswar, for extending necessary facilities and P.K.S Pillai, post graduate student of our Department for active and enthusiastic assistance while collecting the samples at Kovalam beach.

A.L.N. SARMA
TAPAS CHATTERJEE

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REFERENCES

BURN, R. (1960): Australian bivalve gastropods. *Nature 18:* 44-66.

BURN, R. (1965): Rediscovery and taxonomy of *Edetelina typica* Gatliff & Gabriel, ibid. *206:* 735-736.

BURN, R. (1966): The opisthobranchs of a caulerpan microfauna from Fiji. *Proc. malac. Soc. Lond. 37:* 45-65.

DALL, W.H. (1898): Contributions to the Tertiary fauna of Florida with special reference to the Miocene Silex beds of Tampa and the Pliocene beds of Calossahatchie River. Part-IV. *Trans. wagner Free. Inst. Sci. 3:* 1-200.

TABLE 1
AVAILABLE RECORDS OF LIVING REPRESENTATIVES OF BIVALVED GASTROPODS WITH THE ALGAL HABITAT THROUGHOUT THE WORLD SEAS

Species	Habitat	Locality	Author
Berthelinia (Tamanovalva) limax	*Caulerpa okamurai*	Bisan Seto, Inland Sea of Japan.	Kawaguti & Baba 1959
Midorigai australis	*C. brownii* *C. scalpelliformis* *C. simpliciuscula*	Torgay, Victoria, Australia	Burn 1960
B. (Tamanovalva) chloris	*C. sertularioides* *C. racemosa*	Puerto Ballandro Bay, Baja California	Keen & Smith 1961
Julia sp.	–	West side of Saipan, Marina Islands.	Morrison 1961
Midorigai australis	In plankton twos made through *Posidonia* sp.	Port Hacking, Australia	Wisely 1960
Julia japonica	*Microdictyon japonicum*, *Caulerpa ambigua*	Mishima, off the coast of Hagishi Yamaguchi Prefecture, Japan	Kawaguti & Yamasu 1962, 1966
Julia exquisita	On an algal mat of *Laurencia*, *Gracilaria* and *Gracilariopsis*	Koloa, Kauai, Hawaii	Kay 1962
Berthelinia (Tamanovalva) caribbea	*Caulerpa verticellata*	Port Royal, Jamaica	Edmunds 1963
B. (Tamanovalva) pseudochloris	*C. racemosa*	Koloa, Kauai, Hawaii	Kay 1964
B. (Tamanovalva) babai (= *B. typica* Burn 1960)	*C. scalpelliformis* *C. brownii*	Torgay, Victoria, Australia.	Burn 1965.
B. (Edenttellina) typica	*C. brownii*	Flinders, Victoria, Australia.	Burn 1965
B. (Tamanovalva) limax	*C. racemosa*	Mandapam Camp, Gulf of Mannar, India	Prabhakara Rao 1965
B. (Tamanovalva) sp.	*Caulerpa* sp.	Tulear, Madagascar	Legendre 1965
B. (Tamanovalva) caribbea	*C. verticellata* *C. racemosa*	Puerto	Rico Warmke 1966
B. (Tamanovalva) fijiensis	*C. racemosa*	Vitilevu, Fiji	Burn 1966
Berthelinia sp.	*C. racemosa*, *C. taxifolia*	Visakhapatnam, coast Bay of Bengal, India	Ganapati & Sarma 1968
B. (Tamanovalva) caribbea	*C. verticellata*	Port Royal, Jamaica	Grahame 1969
B. (Tamanovalva) limax	*C. racemosa*	Visakhapatnam coast, Bay of Bengal, India	Ganapati & Sarma 1972
B. (Tamanovalva) schlumbergeri	*Halimeda opuntia*	Port Blair, Andaman Islands	Ganapati &Sarma 1972
B. (Tamanovalva) waltairensis	*Caulerpa taxifolia*	Visakhapatnam coast, Bay of Bengal, India	Sarma 1975
B. (Tamanovalva) ganapatii	*C. racemosa*	Visakhapatnam coast, Bay of Bengal, India	Sarma 1975
Julia burni	*Halimeda opuntia*	Port Blair, Andaman Islands	Sarma 1975
Berthelinia sp.	*Caulerpa racemosa*	Kovalam beach, Kerala, Arabian Sea, India	Present report

Edmunds, M. (1963): *Berthelinia caribbea* n. sp., a bivalved gastropod from the West Atlantic. *J. Linn. Soc. Lond. (Zool.) 44:* 731-739.

Ganapati, P.N. & Sarma, A.L.N. (1968): Occurrence of bivalve gastropods (Mollusca) in Visakhapatnam shore. *Curr. Sci. 37:* 689-690.

Ganapati, P.N. & Sarma, A.L.N. (1972): Bivalve gastropods of the Indian Seas. *Proc. Ind. Nat. Sci. Acad. 38-B:* 240-250.

Grahame, J. (1969): The biology of *Berthelinia caribbea* Edmunds. *Bull. Mar. Sci. 19:* 868-879.

Kawaguti, S. & Baba, K. (1959): A preliminary note on a two-valved sacoglossan gastropod *Tamanovalva limax* n. gen., n. sp., from Tamano, Japan. *Biol. J. Okayama Univ. 5:* 177-184.

Kawaguti, S. & Yamasu, T. (1962): *Julia japonica* found living as a bivalve gastropod. *Proc. Japan. Acad. 38:* 284- 287.

Kawaguti, S. & Yamasu, T. (1966): Feeding and Spawning habits of a bivalved gastropod, *Julia japonica. Biol. J. Okayama Univ. 12* : 1-9.

Kay, E.A. (1962): *Julia exquisita* Gould, a bivalved gastropod. *Pacif. Sci. 16:* 434-435.

Kay, E.A. (1964): A new species of *Berthelinia* and its associated sacoglossans in the Hawaiian Islands. *Proc. malac. Soc. Lond. 36:* 191-197.

Keen, A.M. & Smith, A. (1961): West American species of the bivalved gastropod genus *Berthelinia. Proc. calif. Acad. Sci. 30:* 47-66.

Legendre, R. (1965): Presence dans Les eaux Littorales de Madagascar dde Gastropodes Bivalves (opisthobranches - Tectibranches, Sacoglosses). *Bull. Aca. Malgache, N.S. 41:* 89-91

Morrison, J.P.E. (1961): Notes on the bivalved 'Univalves'. *Abstract of the American Malacological Union Annual Reports for 1960:* 18-20.

Prabhakara Rao, K. (1965): Record of bivalve gastropod *Berthelinia limax* (Kawaguti and Baba 1959) from the Indian Ocean. *Nature 208:* 404-405.

Sarma, A.L.N. (1975): Three new species of the Bivalved Gastropods *Julia* and *Berthelinia* found in eastern Indian Ocean. *Jap. Jour. Malac. (Venus) 34:* 11-25.

Warmke, G.L. (1966): Two species of the bivalve gastropod, *Berthelinia*, found in Puerto Rico. *Nautilus 79:* 139- 141.

Wisely, B. (1960): An outline of the development of the bivalve gastropod, *Midorigai australis* Burn. *J. Malac. Soc. Aust. 6:* 37-39.

35. EXTENSION OF RANGE OF A FRESHWATER LEECH *BARBRONIA WEBERI* (BLANCHARD) (ARHYNCHOBDELLAE:ERPOBDELLIDAE) FROM PUNE, MAHARASHTRA

A handful of aquatic vegetation, mainly *Marsilea*, collected from the marshy banks of the river Mutha, near Balgandharva Ranga Mandir in Pune, Maharashtra, disclosed the presence of eight small leeches. These were red in colour and swam actively when placed in an aquarium. Detailed examination after preservation indicated that the species was *Barbronia weberi* (Blanchard), as per the key given by Chandra (1983).

Diagnostic features: Slender, linear form; terete anterior end; flattish posterior end; small, round caudal sucker and distinct clitellum. The specimens also compared well with the full description given by Harding and Moore (1927). One of the collected specimens, however, measured 49 mm. Harding and Moore mentioned the size "....to be 25 to 35 mm, the largest being 36 mm...." Interestingly it was the smaller specimen (30 mm) that showed a well-developed male genital pore and the so-called anterior and posterior accessory copulatory pores. In the 49 mm specimen, the posterior pore was not well marked. Such variations have also been mentioned by Harding and Moore (1927).

This species has so far been reported only from the northern parts of India, viz. Jammu and Kashmir, Himachal Pradesh and Madhya Pradesh (Harding and Moore 1927, Chandra 1983). In fact, no member of the family Erpobdellidae was reported from Maharashtra until fairly recently, when two species of the genus *Herpobdelloidea* were reported (Chandra 1976). This report therefore considerably extends the range of *Barbronia weberi*

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H.V GHATE

References

Chandra, M. (1976): On a small collection of leeches from Maharashtra State, India. *Rec. Zool. Surv. India 69:* 325-328.

Chandra, M. (1983): A checklist of leeches of India. Rec. Zool. Surv. India 80: 265-290.

Harding, W.A. & Moore, J.P. (1927): Fauna of British India, including Ceylon and Burma: Hirudinea. Taylor and Francis, London.

36. THREE NEW RECORDS FOR THE FLORA OF GUJARAT STATE

The intensive botanical explorations, made by the senior author, in Sanjan forests of Gujarat under the auspicies of the Botanical Survey of India's Bulsar District Flora Project yielded three unrecorded angiospermous taxa, namely *Desmanthus virgatus* (L.) Willd. (Mimosaceae), *Exacum lawii* C.B. Cl. (Gentianaceae) and *Macrosolen capitellatus* (Wt. & Arn.) Danser (Loranthaceae). These are reported here for the first time, for the flora of Gujarat (c.f. Shah 1978, Raghavan *et al.* 1981). The identity of the taxa was confirmed by matching the collection with authentically identified specimens at the Sardar Patel University Herbarium. All the three species are rare in the present area. *Desmanthus virgatus* and *Macrosolen capitellatus* are reported from adjoining flora of Dahanu forests in Maharashtra (Shah and Badrinath 1985) but *Exacum lawii* does not occupy a place in cited flora.

Nomenclature and brief notes on ecology, distribution and exsiccata are given for each species. Since the description and illustrations for all three taxa are available in literature, only the reference(s) are cited here. All the specimens are deposited in the Herbarium of S.P. University.

Desmanthus virgatus (L.) Willd., Sp. Pl. 4: 1047. 1805; Wt. & Arn., Prodr. 1:270. 1834; cooke, Fl. Pres. Bombay 1:456. 1908; Shah, J. Bombay Nat. Hist. Soc. 33: 37. 1965.

Rare weed in hedges along roads and around cultivated fields at Govada. It is a native of America, naturalized in the tropics. This plant was reported as a garden escape from Bombay (Shah *loc. cit.*), naturalised weed from Dahanu (Shah and Badrinath *loc. cit.*) and as a garden weed from Bangalore (Saldanha and Singh 1984).

Exsiccata: ASR 3341.

Exacum lawii C.B. cl. in Hk. f. Fl. Brit. India 4: 98. 1883; Cooke, Fl. Pres. Bombay 2: 189. 1908.

A few plants were found among grasses in moist ground at Zaroli. This species can be easily separated from *E. pedunculatum* L. and *E. pumilum* Griesp. by its solitary arrangement of flowers.

Exsiccata : ASR 2924.

Macrosolen capitellatus (Wt. & Arn.) Danser, Blumea 4: 36. 1936; Wiens in Abeywick. Fl. Ceylon 1:64. 1973. *Loranthus capitellatus* Wt. & Arn. Prodr. 382. 1834; Cooke, Fl. Pres. Bombay 2: 550. 1908.

A rare parasite, noted on *Manilkara hexandra* (Roxb.) Dub., at Govada. This species resembles *Dendrophthoe falcata* (L.f.) Etting., the common parasite on a variety of hosts in the present locality. These two taxa can be hardly distinguished in vegetative condition.

Exsiccata: ASR 3330.

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A.S. REDDY
J.A. INAMADAR

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REFERENCES

RAGHAVAN, R.S., WADHWA, B.M., ANSARI, M.Y. & RAO, R.S. (1981): A Checklist of the Plants of Gujarat. *Rec. bot. Surv. India 21(2):* 1-127.

SALDANHA, C.J. & SINGH, B.G. (1984): *In:* Flora of Karnataka State. vol. I. Oxford & IBH Publishing Co., New Delhi.

SHAH, G.L. (1978): Flora of Gujarat State Part I & II. Sardar Patel University, Gujarat.

SHAH, G.L. & BADRINATH, V. (1985): A contribution to the Angiospermic Flora of Dahanu Forest division in Maharashtra State. *J. Econ. Tax. Bot. 6(1):* 117-141.

37. GREGARIOUS OCCURRENCE OF *CLEOME CHELIDONII* L.F. (CAPPARACEAE) IN BANGALORE DISTRICT, KARNATAKA

The latest publication on the 'Flora of Karnataka' by Saldanha (1984) has treated *Cleome chelidonii* L.f. of the Family Capparaceae on the basis of earlier collections made from Uttara Kannada (Dharwad district) by Sedgewick (coll. No. 3103) and the collections made by Rao and Razi (1981) from Talkad and Mahadeshwaramalai in Mysore district. Excepting these, there are no reports on its occurrence in any other part of Karnataka. In most of the earlier reports the plant is said to occur occasionally, but on the contrary we came across a gregarious population of *C. chelidonii* at Harohally, North Bangalore district (Coll. VB 975, 30-7-1986, UAS Herbarium), which incidentally forms the first record for Bangalore district.

Cleome chelidonii has been reported from Bombay Presidency (Cooke 1901) and present Maharashtra state (Santapau 1967, Naik 1979), Bhopal in Madhya Pradesh (Oomachan 1977), Madras and North Circars in Tamil Nadu (Mayuranathan 1981, Gamble 1915).

There are quite a number of differences in the description of the plant as given by various authors. Most of the authors mention that the plant is prickly hairy (Saldanha 1984, Rao and Razi 1981, Wight 1840, Mayuranathan 1981). Cooke (*loc. cit.*) and Steenis (1960-72) mention that the plant is glabrous except for 'scattered appressed hairs from bulbous or glandular bases. Hooker

TABLE 1
VARIATION IN FLOWERING AND FRUITING SEASON IN *Cleome chelidonii*

Locality	Flowering	Fruiting	Author
Karnataka	October	May	Saldanha (1984)
Bombay	July	February	Cooke (1901)
Bhopal	July	February	Oommachan (1977)
Osmanabad	June	October	Naik (1979)
Madras	December	January	Mayuranathan (1981)
Malaysia	January	December	Steenis (1960-72)
Mysore	April	July	Rao & Razi (1981)
Bangalore	June	August	Present authors

(1875) mentions that the plants of *C. chelidonii* are glabrous or sparsely scabrid with few bristles. In Wt. Icon t. 319, the plant is shown to possess hispid hairs almost throughout the body of the plant. But most of the plants collected by us were almost glabrous with smooth stem except in axillary branches, petioles, and petiolules of the basal leaves, which showed a few sparsely distributed scale-like, pointed appressed pale white hairs. More strigose hairs were noticed near the point where all petiolules arise.

However, the earlier authors, without exception, mention that both surfaces of the leaves are rather densely clothed with appressed bulbous-based hairs. In a few specimens presently collected the leaves did posses hairs on both surfaces. Saldanha (1984) and Rao and Razi (1981) are the only authors who mention that the siliqua is glandular hairy, while all others have observed that it is glabrous, and our specimen conforms with the latter observations. Rao and Razi (*loc. cit.*) mention that the carpel in *C. chelidonii* is 4.5 cm long, which on the contrary is hardly 1 cm long as confirmed by us by re-examination of the herbarium specimens at the Mysore Herbarium.

There is also variation regarding the flowering and fruiting season of *C. chelidonii* as mentioned by earlier authors (Table 1).

Saldanha (1984) cites that *C. chelidonii* occurs in sandy and arid soils, while other authors report that it occurs in marshlands such as freshwater swamps, fallow rice and sugarcane fields, roadside ditches in shallow waters (Cooke 1901, Backer and Brink 1963-65, Oomachan 1977, Naik 1979, Mayuranathan 1981, Steenis 1960-72, Hooker 1875). The present collection was made from tank bed with clayey heavy soils from a large population occupying over 20 ha. of tank bed and forming a dominant population.

V BHASKAR
June 15, 1989 C.G. KUSHALAPPA

REFERENCES

BACKER, C.A. & BRINK, R.C. (1963-65): Flora of Java 1: 182.

COOKE, T. (1901): Flora of Bombay Presidency 1:39.

GAMBLE, J.C. (1915): Flora of Presidency of Madras 1:41.

HOOKER, J.D. (1875): Flora of British India 1:170.

MAYURANATHAN, P.V. (1981): The flowering plants of Madras. Periodical Exp. Book Agency, Delhi.

NAIK, V.N. (1979): Flora of Osmanabad. Venus Publ., Aurangabad.

OOMACHAN, M. (1977): Flora of Bhopal. J.K. Jain Bros., Bhopal.

RAO, R.R. & RAZI, B.A. (1981): Flora of Mysore District. TTPP, New Delhi.

SALDANHA, C.J. (1984): Flora of Karnataka. Oxford & IBH, New Delhi.

SANTAPAU, H. (1967): The flora of Khandala on the Western Ghats of India. *Rec. Bot. Surv. India 16(1):* 1355.

STEENIS, C.G.G.J. van (1960-72): Flora Malesiana 6: 102.

WIGHT, R. (1840): Icones Plantarum indiae Orinetalis. Madras.

38. ON THE DISTRIBUTION OF *PARAMIGNYA ARMATA* (THW.) OLIV. (RUTACEAE)

Thwaites (1858) erected the genus *Arthromischus* with the lone species *A. armatus* based on his own collections made in Sri Lanka (Ceylon) (C.P. 1197 & C.P. 3115). He distinguished it from *Paramignya* in having jointed leaf stalk, small calyx, and uniovulate ovary locules. Oliver (1861) who studied critically the genera of Aurantiaceae, particularly of the Indian region, however, did not accept *Arthromischus* as distinct, as none of the characters mentioned by Thwaites was found which could distinguish it from *Paramignya* and other related genera. Oliver (loc. cit.), therefore, reduced *Arthromischus* to the synonymy of *Paramignya* and made the necessary transfer to *Paramignya armata* (Thw.) Oliv. Both Thwaites and Oliver considered the above species as growing only in

the hotter parts of Sri Lanka.

Beddome (1874) in Icone Plantarum Indiae Orientalis recorded for the first time his own collections from peninsular India (Wynaad-Coorg; 600-1200 m) as *P. armata* (Thw.) Oliv. with illustrations and a detailed description. But Tanaka (1930) pointed out that although the description provided by Beddome (*loc. cit.*) was applicable to the true *P. armata* (Thw.) Oliv., the accompanying illustrations represented a closely related undescribed species. Accordingly Tanaka (*loc. cit.*) described anew the peninsular Indian elements illustrated by Beddome (*loc. cit*) as *P. beddomei* and cited one of Beddome's later collections from Anamalai hills (*Beddome* 1052) as the type. The various characters by which Tanaka (*loc. cit.*) distinguished his new species from *P. armata* (Thw.) Oliv. can be presented in a key as follows:

Branches not predominantly zig-zag, glabrous; flowers in fascicles of 3 to 8, ovate in buds, 6-10 mm long; calyx lobes triangular, acute; staminal filaments sparsely pubescent to the middle from base; anthers shorter; stigma globose and berries apiculate. .... *P. armata*

Branches predominantly zig-zag, often pubescent; flowers solitary, sometimes in pairs[1], cylindric in buds, 10-20 mm long; calyx lobes conspicuously auriculate, obtuse; staminal filaments very fuzzy throughout, anthers longer; stigma oblate; berries not apiculate .... *P. beddomei*

Tanaka (*loc. cit.*) further stated that *P. beddomei* occurs both in peninsular India and Sri Lanka while *P. armata* is confined to Sri Lanka.

J.D. Hooker (1875) in Flora of British India described *P. armata* exclusively as a Sri Lankan element. It may be presumed that probably Hooker (*loc. cit.*) did not have access to Beddome's work which appeared more or less simultaneously. On the other hand, Gamble (1915) followed Beddome (*loc. cit.*) by enumerating the southern peninsular Indian elements as *P. armata*. Fischer (1936), however, added *P. beddomei* Tanaka to Gamble's Flora of Madras, wherein he recognised both *P. armata* and *P. beddomei* for southern India with a key to distinguish the two species.

Despite Tanaka's (*loc. cit.*) clarification that the elements reported as *P. armata* from peninsular India, represent only *P. beddomei*, in some of the recent floristic accounts both *P. armata* and *P. beddomei* are still being reported for peninsular India. This has prompted us to analyse and re-evaluate afresh the identity and distribution of the two species. On critical examination of the available literature and a good number of herbarium specimens housed in Central National Herbarium (CAL) and Madras Herbarium (MH), it has been consistently observed that specimens identified as *P. armata* collected from southern India were invariably erroneous and they represent *P. beddomei* Tanaka. Incidentally, workers like Swingle (1967) and Stone (1985) also considered *P. beddomei* as occurring both in peninsular India and Sri Lanka while *P. armata* as endemic to Sri Lanka only.

We therefore conclude that all the earlier reports of *P. armata* from peninsular India should be regarded as *P. beddomei* Tanaka only.

The nomenclature, distribution, ecology, and exsiccatae examined of these two species are given below for future guidance.

Paramignya armata (Thw.) Oliv., J. Linn. Soc. Bot. 5. Suppl. 2: 43.1861; Hook. f. in Hook. f., Fl. Brit. Ind. 1: 511. 1875; Trimen, Handb. Fl. Ceylon 1: 225. 1893; Engler in Nat. Pflanzenfam. 3(4): 192. 1896; Seingle, Citrus Ind. 1: 274. 1967; Stone in Dassanayake & Fosberg (ed.), A. Rev. Handb. Fl. Ceylon 5: 467. 1985. *Arthromischus armatus* Thw. Enum. Pl. Zeyl. 47. 1858. *Atlantia armata* (Thw.) Guill. in Lecomte, Not. Syst. 6: 182. 1910; Engler in Nat. Pflanzenfam. 3(4): ed. 2. 19a: 329. 1931.

Type: *Thwaites* C. P. 1197 (Lecto, K.).

Distribution: Endemic to Sri Lanka.

Ecology: Grows in drier parts of the island up to an elevation of *c*. 200 m.

Flowers.: November and December. **Fruits. :** April.

Specimens examined: locality unknown: *Thwaites* 3115 (CAL).

Paramignya beddomei Tanaka, J. Bot. 68: 230. 1930; Fischer in Gamble, Fl. Pres. Madras 3: 1872. 1936; Swingle, Citrus Ind. 1: 274. 1967; Stone in Dessanayake & Fosberg (ed.), A. Rev. Handb. Fl. Ceylon 5: 467. 1985. *P. armata auct.* non '(Thw.) Oliv.' : Beddome, Ic. Pl. Ind. Or. 65. Pl. 275 (excl. descr.) 1874; Gamble, Fl. Pres. Madras 1: 158. 1915 (1:113. 1957, repr. ed.).

Type: *Beddome* 1052, Anamalai hills, Madras (BM).

Distribution: INDIA (Tamil Nadu, Kerala) and Sri Lanka.

Ecology: In evergreen forests at higher altitudes (850-1350 m).

Flowers : September - January. **Fruits. :** February - July.

Specimens examined: Tamil Nadu: Kanyakumari district: en route Nalumukku, Upper Kodayar, 1350 m, Henry 70328 (CAL, MH). Tirunelveli district: Courtallum, *Beddome s.n.* (MH); Kalivayalpet to Hanningtino bungalow, *Barber* 3081 (CAL, MH); Kannikatti, 850 m, *Henry* 19868 (MH); *sine legit., numero & loc.* (CAL, Acc. Nos. 76308, 76311).

Kerala : Cannanore district : Theerthundamalai, 900 m, *V.S. Ramachandran* 53962 (MH). Palghat district: Silent Valley R.F., Northern Slopes, 900 m, *N.C. Nair* 56659 (CAL, MH); Poochi para, 1100 m, *N.C. Nair* 69518 (MH), *V.J. Nair* 67419 (CAL, MH); Below Jinalghat, 1200 m. *N.C. Nair* 77252 (MH). Wynaad district: *Beddome S.N.* (MH); Attapadi hills, 975 m, *Fischer* 2784

[1]Observations by the present author

(CAL, DD); *sine legit., numero & loc.* (MH - Acc. No. 8400).

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References

BEDDOME, R.H. (1874): Icone Plantarum Indiae Orientalis 65. Pl. 275.

FISCHER, C.E.C. (1936): *In:* Gamble's Flora of the Presidency of Madras 3: 1872 (3: 1295. 1957, repr. ed.). Calcutta.

GAMBLE, J.S. (1915): Flora of the Presidency of Madras 1: 158 (1:113. 1957, repr. ed.).

HOOKER, J.D. (1875): Flora of British India 1: 511.

TANAKA, T. (1930): *Journal of Botany 68:* 230.

THWAITES, G.H.K. (1858): Enumeratio Plantarum Zeylanicae - an enumeration of Ceylon Plants. 47.

STONE, B.C. (1985): *In:* A revised handbook to the Flora of ceylon 5: 467. (Eds: Dassanayake & Fosberg), New Delhi.

SWINGLE, W.T. (1967): *In:* Webber, H.J., and Batchelor, L.D. The Citrus Industry 1: 274. Univ. of California Press, Berkeley. Revised edition (by P. Reese).

39. TAXONOMY OF *NEONOTONIA WIGHTII* (WIGHT & ARN.) LACKEY (PAPILIONACEAE)

The name *Notonia* coined by Wight and Arnott (1834) for a genus of the Leguminosae, is a later homonym of *Notonia* of de Candolle (1833) of the compositae. When they learnt of the existence of an earlier homonym, they re-named it *Johnia.* However, this also happens to be a later homonym of *Johnia* of Roxburgh (1832), a synonym of *Salacia* of the Hippocrateaceae. Verdcourt (1966) treated *Notonia* Wight and Arnott as a synonym of the conserved name *Glycine* Willd. and commented that Indian plants are polymorphic and extremely variable climbers. Meyer (1836) described the genus *Bujacia* with two species, viz. *B. anonychia* (*G. wightii*) and *B. gampsonychia* (*Teramnus labialis* (L.) Spreng.).

Lackey (1977) observed that the description given by Meyer (*loc. cit.*) for his genus applies only to *B. gampsonychia* and excludes the characters of *Glycine wightii.* Therefore he proposed a new generic name *Neonotonia.* Meanwhile, Sen (1977) published a new variety *coimbatorensis* under *Glycine* Willd. based on certain features like the plants being less hairy, having more elongated racemes and flowers being more lax on the axis and not so much overlapping. However, Wight and Arnott (*loc. cit.*) describe, 'Racemes axillary, at first dense, short and comose (from the length of the subulate hairy bracteas, bracteoles and calyx segments); afterwards much elongated and distant-flowered, particularly in the lower part' and further observed two types of hairs, (1) shorter and more deflexed, and (2) longer and almost horizontal. The collated study of 123 specimens available in MH besides types also invariably corroborates the opinion of Wight and Arnott (*loc. cit.*), and further proves that the variety proposed by Sen (*loc. cit.*) is one of continuous variations of the species and thereby does not deserve a taxonomic status. Hence the correct nomenclature of the taxon concerned is as follows:

Neonotonia wightii (Wight & Arn.) Lackey in Phytologia 37(3): 210. 1977, subsp. *wightii* var. *wightii. Notonia wightii* Wight & Arn., Prodr. 208. 1834. *Johnia wightii* (Wight & Arn.) Wight & Prodr. 449.1834.

Glycine javanica auct. non L. 1753: Baker in Hook. f., Fl. Brit. India 2: 183. 1876; Gamble, Fl. Pres. Madras 351. 1918 (1:248. 1957 repr. ed.).

G. wightii (Wight & Arn.) Verdc. subsp. *wightii* var. *coimbatorensis* Sen in J. Bombay nat. Hist. Soc. 74: 330. 1977. *Holotype:* Wetlands Coimbatore, Tamil Nadu, ± 468 m, 21 November 1965, *M. Chandrabose* 28823 (MH).

Neonotonia wightii (Wight & Arn.) Lackey subsp. *wightii* var. *coimbatorensis* (Sen) Karthik. in Indian J. Forestry 4: 65. 1981.

Type: Wallich Num. List. nos. 5528 & 5530 (microfische) (Syntype). R. Wight, *Acc. No.* 15806 & 15805 (Syntypes) (MH).

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References

DE CANDOLLE, A.P. (1833): Genres noveaux appartenant a la famille des Composees ou Synantherees in J.B.A. Guillemin's Archives de Botanique. Paris 2*:* 514-519.

KARTHIKEYAN, S. (1981): The correct name of *Glycine wightii*

Verdcourt ssp. *wightii* var. *coimbatorensis* Sen. *Indian J. Forestry 4(1):* 65.
LACKEY, J.A. (1977): *Neonotonia*, A new generic name to include *Glycine wightii* (Wight & Arn.) Verdcourt (Leguminosae, Papilionoideae). *Phytologia 37(3):* 209-212.
MEYER, E.H.F. (1836): Commentariorum de plantis Africae australioris. Leipzing p. 127.
ROXBURGH, W. (1832): Flora Indica. Serampore *1:* 168.
SEN, A. (1977): A new variety of *Glycine wightii* subsp. *wightii* Verdcourt from South India. *J. Bombay nat. Hist. Soc. 74:* 330-332.
VERDCOURT, B. (1966): A proposal concerning *Glycine* L. *Taxon 15:* 34-36.
WIGHT, R. & ARNOTT, G.A.W. (1834): Prodromus Florae Peninsulae Indiae Orientalis. London 207-208 & 449.

40. VEGETATIVE AND FLOWERING PHENOLOGIES OF SOME WEEDY LABIATES IN RELATION TO RAINFALL

There have been very few studies attempted to define flowering and other phenological events in tropical latitudes (Stern and Roche 1974, Frankie *et al.* 1974, Gentry 1974, Bawa 1977, Opler *et al.* 1976, Subba Reddi and Reddi 1982). They demonstrate that breaking of dormancy leads directly or indirectly to anthesis as a result of reduction of water stress and temperature drop associated with rainstorms or monsoon rains. The adaptations in floral seasonality, phenology and morphology are the raw materials which produce various pollination mechanisms in different flower species. This paper examines the vegetative and blooming phenology of five different species of Lamiaceae which flower annually in relation to rainfall.

Role of rainfall in vegetative and flowering phenology: In the course of my studies of the reproductive behaviour and ecology of tropical weedy Labiates in Andhra Pradesh from 1983 to 1987, I have found that rainfall directly or indirectly plays an important role in the initiation, timing and synchronization of vegetative and flowering phenology with the resultant reduction in water stress or sharp temperature drop in *Ocimum americanum*, *O. basilicum*, *Anisomeles malabarica*, *A. indica* and *Hyptis suaveolens*. The species are herbaceous perennials and grow from perennating root stocks or seeds. Except for *A. indica*, their natural habitats are disturbed and undisturbed places with soils saturated or unsaturated. *A. indica* is confined to undisturbed areas with saturated soils. They usually have patchy distribution, and each patch may reseed itself and persist for several years.

Ocimum and *Anisomeles* broke dormancy and initiated vegetative growth with the first rains in June after a 3 month dry spell. Two weeks later *Ocimum* began flowering in October. *Anisomeles* began flowering 5 weeks after the end of the dry spell and continued until January. In *A. indica* flowering was associated with moisture content of the soil. Vegetative growth in *Hyptis* appeared in September and flowering began 3 weeks later and continued until December. Such phenology has been evident in *Croton bonplandianum* and *Euphorbia geniculata* (Subba Reddi and Reddi 1982). It shows that these species have a long flowering season, which is a characteristic feature of weedy flora (Baker 1974). Each individual plant produced flowers every day throughout its flowering phase, a feature known as steady state flowering (Gentry 1974). The continuous flowering for prolonged periods, particularly in rainy seasons, is a rare characteristic of perennial shrubs or herbs. In this sense, it is a peculiar perennial feature in these Labiates.

Although rainfall has a great bearing on breaking dormancy and stimulating vegetative growth and then flowering, it does not influence the timings of anthesis or anther dehiscence in any of the five species, unlike what has been reported by Opler *et al.* (1976). In *Anisomeles* and *Hyptis*, anthesis as well as anther dehiscence is delayed about an hour on cloudy and foggy days. Pollinator activity is similarly delayed.

Floral features in relation to pollinators: The individuals of out-crossing species must flower in relative synchrony to effect appropriate gene exchange and seed set. Furthermore, for outcrossing different species must have seasonally different flowering periods or be separated by diurnal anthesis times. The outcrossing *Randia* species which have simultaneous flowering have different diurnal anthesis times and different pollinators (Opler *et al.* 1976). The two *Anisomeles* species are mainly out-crossers and usually occupy different habitats. They have simultaneous seasonal flowering but have differnt diurnal anthesis times. Their diurnal pollinators are the same. Competition for such pollinators has been avoided by their natural distribution in different habitats.

The two *Ocimum* and *Hyptis* species, on the other hand, are mainly selfers and usually grow intermingled with each other. The flexibility in their mating system to reproduce by selfing or crossing has made it possible to overcome unfavourable pollinator conditions for their continuous perpetuation in colonizing different habitats.

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REFERENCES

BAKER, H.G. (1974): The evolution of weeds. *Ann. Rev. Ecol. & Syst. 5:* 1-24.

BAWA, K.S. (1977): The Reproductive biology of *Cupania guatemalensis* Radlk. (Sapindaceae). *Evolution 31:* 52-63.

FRANKIE, G.W., BAKER, H.G. & OPLER, P.A. (1974): Comparative phenological studies of trees in tropical wet and dry forests in the low lands of Cost Rica. *J. Ecol. 62:* 881-919.

GENTRY, A.H. (1974): Coevolutionary patterns in central American Bignoniaceae. *Ann. Missouri Bot. Gard. 61:* 728-759.

OPLER, P.A., FRANKIE, G.W. & BAKER, H.G. (1976): Rainfall as a factor in the release, timing, and synchronization of anthesis by tropical trees and shrubs. *J. Biogeography 3:* 231-236.

STERN, K. & ROCHE, L. (1974): Genetics of Forest Ecosystems. Springer-Verlag, Berlin. pp. 330.

SUBBA REDDI, C. & REDDI, E.U.B. (1982): Flowering phenology in some Euphorbiaceae species. *Indian bot.* Reptr. *1:* 150-155.

41. FIRST REPORT ON TYPE LOCALITY AND REDISCOVERY IN NATURE OF A RARE INDIAN ORCHID SPECIES, *BULBOPHYLLUM ROTHSCHILDIANUM* (O'BRIEN) J.J. SMITH

(With a text-figure)

During the course of a botanical exploration in the Mokokchung district (25°45'-26°36' N; 94°-94°45'E; average annual rainfall 2500-3000 mm) of Nagaland, we collected some interesting and rare species of *Bulbophyllum* from certain forest pockets. One of these was identified as *B. rothschildianum.* The species has been reported only once from the hills beyond Darjeeling in the eastern Himalayas as a new species named *Cirrhopetalum rothschildianum* by O'Brien in Gard. Chron. 1895, 2:608. O'Brien's report is based merely on specimens received from a nursery man somewhere in the hills beyond Darjeeling. Further, the report is silent about the actual place of its occurrence, habitat, flowering time, and distribution. Our search for the type locality of this species in and around Darjeeling hills proved futile, leading to the conclusion that the hills beyond Darjeeling cannot be the type locality. So far no one knows the type locality of this orchid species. Subsequent to O'Brien's report in 1895 there is no other report on its collection from nature (Seidenfeden 1973). The present collection from Mokokchung district is after a lapse of about a hundred years and forms the first report on its type locality.

The species, commonly called red chimney, is perhaps the most beautiful among all bulbophyllums and horticulturally, it is one of the most attractive orchid species. The whole flower is so remarkably attractive that it commands attention even from those who prefer none but the most flamboyant orchids. At the meeting of the Orchid Committee of the Royal Horticultural Society on 15 October 1895, Hon. Walter Rothschild exhibited what was unanimously agreed to be the handsomest of the plume bearing section of *Cirrhopetalum*, and under the above name, it was awarded a First-Class Certificate (O'Brien 1895). It is also the parental source of many attractive orchid hybrids. One such hybrid, i.e. *Cirrhopetalum* 'Elizabeth Ann' (*rothschildianum* x *longissimum*) commonly known as buckleberry was awarded the Award of Merit by the American Orchid Society (Linder 1987).

Bulbophyllum rothschildianum (O'Brien) J.J. Smith, Bull. Buitz. 2. s. 8: 27, 1912. *Cirrhopetalum rothschildianum* O'Brien, Gard. Chron. 1895. 2: 608; O'Brien, Proc. R. Hort. Soc. 19: 208, Fig. 83, 1896; Rolfe, Orch. Rev. 15: 328, 1907; Gard. Chron. 60: 188, Fig. 75, 1916; Orch. Rev. 30:353; 1922; J.T.B., Gard. Chron. 78: 288; 1925; R.E. Arnold, Orch. REv. 45: 275, 1937; Orch. Rev. 65: 36, 1957; Seidenf., Notes on *Cirrhopetalum* in Dansk Bot. Arkiv. 29. 1973.

A creeping epiphytic plant with a stout rhizome, growth sympodial; pseudobulbs 4-angled, borne 5 cm apart, varying in form from ovate to pear-shaped, each 1-leaved. Leaf fleshy, erect, elliptic - oblong, the apex retuse, the base twisted, up to 16 cm long, 3 cm broad, scape erect, 13-14 cm in height, bearing a terminal one-sided umbel of bright crimson-purple. Flowers blotched with yellow on the sepals, each flower over 15 cm in length and 1.5 to 2 cm across the broadest part of the lower sepals, the cucullate upper sepal yellow with purple lines, and with marginal fringe and a very sensitive plume of a purple colour at the apex, the lower sepals with 2 slender tail-like appendages; the petals are narrower, but similarly coloured and decorated; the triangular, grooved, hinged labellum is purple (Fig. 1).

Flowering: September - October.

Specimen cited: INDIA: Mokokchung district (Nagaland): Longkhum, 11 Oct. 1987, *Gurung 847* (NEHU). The abbreviation 'NEHU' is used for the herbarium of the North Eastern Hill University; it has not yet been registered in Index Herbarium.

Distribution: INDIA: Mokokchung (Nagaland), Hills beyond Darjeeling (7) (Fig. 2). Epiphytic on tree trunks in mixed evergreen broad-leaved humid forest, predominantly composed of *Elaeocarpus floribundus*, *Quercus serrata*, *Cinnamomum* sp. and *Engelhardtia spicata.*

We are grateful to Dr. Jeffrey J. Wood, Orchid Her-

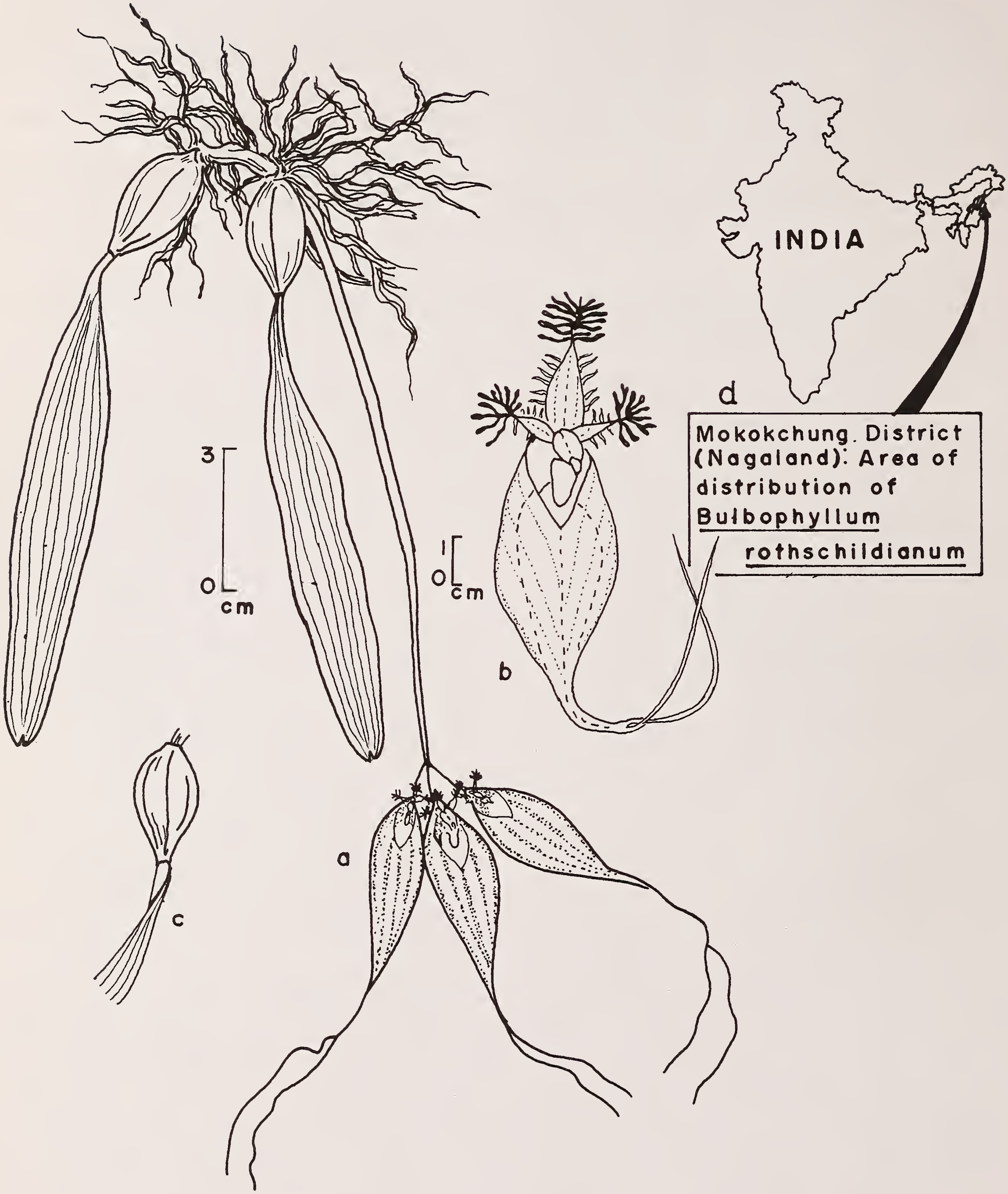


Fig. 1. *Bulbophyllum rothschildianum* (O'Brien) J.J. Smith
a. Habit; b. Flower, c. Twisted leaf-base on a pseudobulb; d. Map of India showing the type locality

barium, Royal Botanic Gardens, Kew, for his generous assistance in supplying a photocopy each of the type specimen and the original description, and to the Head of the Department of Botany, North- Eastern Hill University, Shillong, for providing necessary facilities.

P.B. GURUNG
Y. KUMAR
R.S. TRIPATHI

February 16, 1990

REFERENCES

LINDER, A.K. (1987): Growing Bulbophyllums (Including Cirrhopetalums). *American Orchid Soc. Bull. 56(12):* 1261-65.

O'BRIEN (1895): *Cirrhopetalum rothschildianum.* Gard. Chron. 2: 608.

SEIDENFEDEN, G. (1973): Notes on *Cirrhopetalum. Dansk Bot. Arkiv 29.*

SMITH, J.J. (1912): *Bulbophyllum* Thou. Sect. *Cirrhopetalum. Bull. Jard. Bot. Buitenzorg 2. ser 8:* 19-29.

42. OCCURRENCE OF THE BAMBOO *DENDROCALAMUS PATELLARIS* IN THE KUMAON HILLS, UTTAR PRADESH

(With a text-figure)

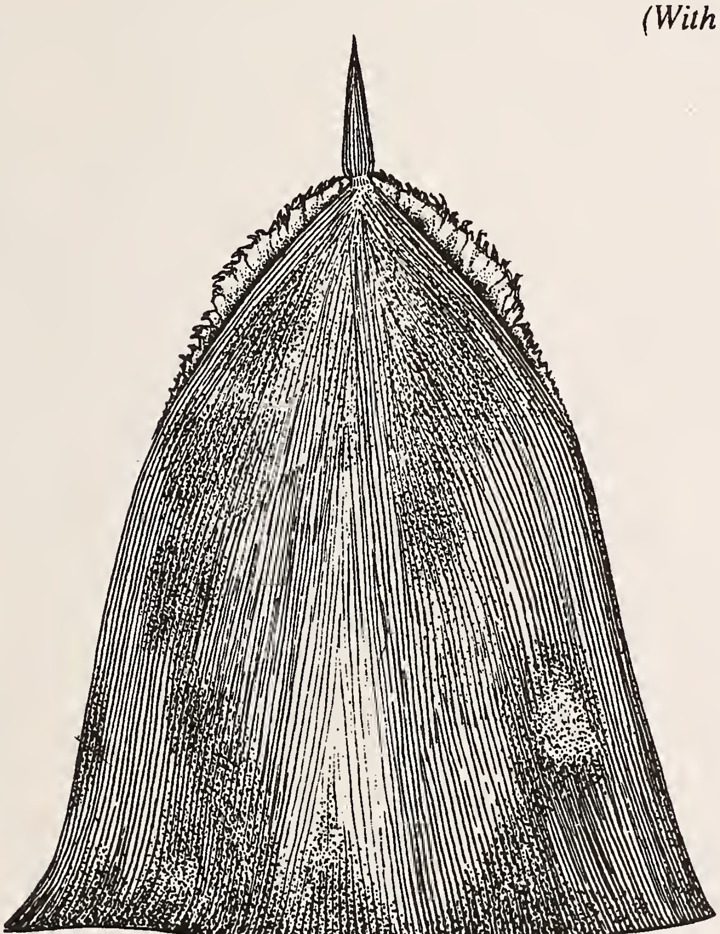


Fig. 1. Culm-sheath of *Dendrocalamus patellaris* Gamble

During the course of bamboo identification in DD (F.R.I. Herbarium, Dehra Dun), I came across 11 herbarium sheets of single collection of *Dendrocalamus patellaris* Gamble, collected from Kalona, Nainital Forest Division, 1200 m, on 4 July 1965, by *T. Suyal.* Regarding its wild occurrence G.C. Pandey, ex Chief Conservator and B.N. Dwivedi, Conservator, Forest Department, Uttar Pradesh, informed me that in Kalona area this bamboo is frequently found in association with *Dendrocalamus strictus.*

According to Gamble (1896 a, b), Bor (1940) and Vermah and Bahadur (1980), *D. patellaris* is known from Arunachal Pradesh, Assam, north Bengal and Sikkim. Camus and Camus (1923) have mentioned its occurrence in Vietnam. Recently Li Dezhu and Hsueh Chiju (1989) have recorded it from China. The present report of its occurrence from Kumaon hills, Uttar Pradesh, is therefore of phytogeographical interest. It is called *pagjiok, pagjiok-pao* by the Lepchas in Sikkim, *footoong* in Assam by Mikirs, while in Kumaon hills it is locally called *lowbans.* In vegetative condition it can be easily distinguished from other bamboos by its softly hairy ring on the nodes and membraneous, fimbriate pale fringe at the margins of culm-sheaths. Illustration of culm-sheath has been provided for easy identification.

May 12, 1990

H.B. NAITHANI

REFERENCES

BOR, N.L. (1940): Gramineae, in Fl. Assam 5: 1-480.

CAMUS, E.G. & CAMUS, A. (1923): Gramineae in Lecomte, *Fl. Gen. Ind. Chin. 7:* 202-650.

GAMBLE, J.S. (1896a): The Bambuseae of British India - *Ann. Roy. Bot. Gard. Cal. 7:* 1-133.

GAMBLE, J.S. (1896b): *In:* Hooker, J.D., Fl. Brit. Ind. 7: 375-420.

LI DEZHU & HSUEH CHIJU (1989): A study on the genus *Dendrocalamus* Nees from China. *J. Bamboo Res. 8(1):* 25-43.

VERMAH, J.C. & BAHADUR, K.N. (1980): Country Report and Status of Research on Bamboos in India - *Indian For. Rec. (n.s.) Bot. 6(1):* 1-28.

43. FORKING OF FRONDS IN CERTAIN FERNS

(*With eight text-figures*)

The polypodiaceous fern genus *Lepisorus* (J. Smith) Ching and *Pyrrosia* Mirbel are simple leaved and *Phymatopteris* Pichi-Sermolli species are 1-pinnate. During the course of our fern collection from Pithoragarh district of Kumaon (western Himalaya) one specimen each of *Lepisorus scolopendrium* (D. Don) Mehra et Bir and *Phymatopteris ebenipes* (Hook.) Pichi-Sermolli, four specimens of *Lepisorus tenuipes* Khullar et Ching and six specimens of *Pyrrosia flocculosa* (D. Don) Ching were collected in which the lamina is variously forked. Though freak, these specimens may throw some light on the phylogeny of these ferns.

In a freak specimen of *L. scolopendrium* the lamina is dichotomously branched to about 5 cm from the apex (Fig. 7). The mid-vein is also dichotomously branched. The forking of lamina in *L. tenuipes* (Figs. 2,5,6) is as deep as in *L. scolopendrium.* In each specimen the mid-vein is also clearly dichotomously branched. The monstrous fronds of *P. flocculosa* are remarkably forked. In one specimen the lamina is forked about 3 cm behind the apex, and both the lobes are once again forked (Fig. 1). Interestingly the midrib is clearly dichotomously branched at the middle of the lamina. In another specimen the lamina is several times forked at the apex (Fig. 3). In almost all the cases the mid-rib is also subsequently branched. The venation in these specimens in general is identical to that found in normal fronds. However, some detached veins are also seen (Fig. 4). The forking in a frond of *P. ebenipes* is rather more interesting. In this specimen the stipe is dichotomously branched from just behind the basal part of the lamina, thus two distinct lamina are produced from a single stipe (Fig. 8).

While discussing the dichotomous branching of lamina of *Pleopeltis simplex* Sw. (= *Lepisorus scolopendrium),* Kashyap and Mehra (1934) concluded that this dichotomous branching of lamina is comparable with the branching of fronds in *Cheiropleuria, Dipteris conjugata* and *Hausmannia dichotoma.* Supporting Bower's (1917) contention that many polypodioid ferns are derived from Dipteridaceae, Kashyap and Mehra (1934) argued that this unusual branching of lamina probably represents a reversion to the ancestral character.

Nayar and Chandra (1965) indicated that in *Pyrrosia manni* there is a tendency of pinnate lobing in the lamina margins. The abnormal lamina with frequent forking of apex in *Pyrrosia flocculosa* as described above resemble closely the fronds of *Platycerium* Desv. and some species of *Dipteris* Reinw. Nayar (1970) placed both *Platycerium* and *Pyrrosia* in subfamily Platycerioideae of the family Polypodiaceae. Close relationships between *Platycerium* and *Pyrrosia* have also been suggested by many workers (Copeland 1947, Holttum 1954).

Origin of *Platycerium* and *Pyrrosia* from a common ancestor as pointed out by Holttum (1954) is more convincing. *Pyrrosia* on the one hand is known to be nearer to *Pleopeltis* (= *Lepisorus);* on the other it has affinities with *Phymatodes* (= *Phymatopteris)* (Copeland 1947). Dichotomous branching of stipe to give rise to two identical lamina in *Phymatopteris ebenipes* is much like dichotomous branching known in *Dipteris lobbiana.* In the latter the stipe forks 2-3 times and thereafter the lamina forks frequently. It can be concluded that in the monostrous specimens of *Lepisorus, Phymatopteris* and *Pyrrosia* the forking of lamina shows an atavistic character if we agree that many polypodiaceous ferns are derived from Dipteridaceae as suggested by Bower (1917).

We thank the University Grants Commission, New Delhi, for financial help.

N. PUNETHA
B.S. KHOLIA

January 27, 1990

References

Bower, F.O. (1917): Studies on the phylogeny of filicales - VI. *Ann. Bot.* p. 1.

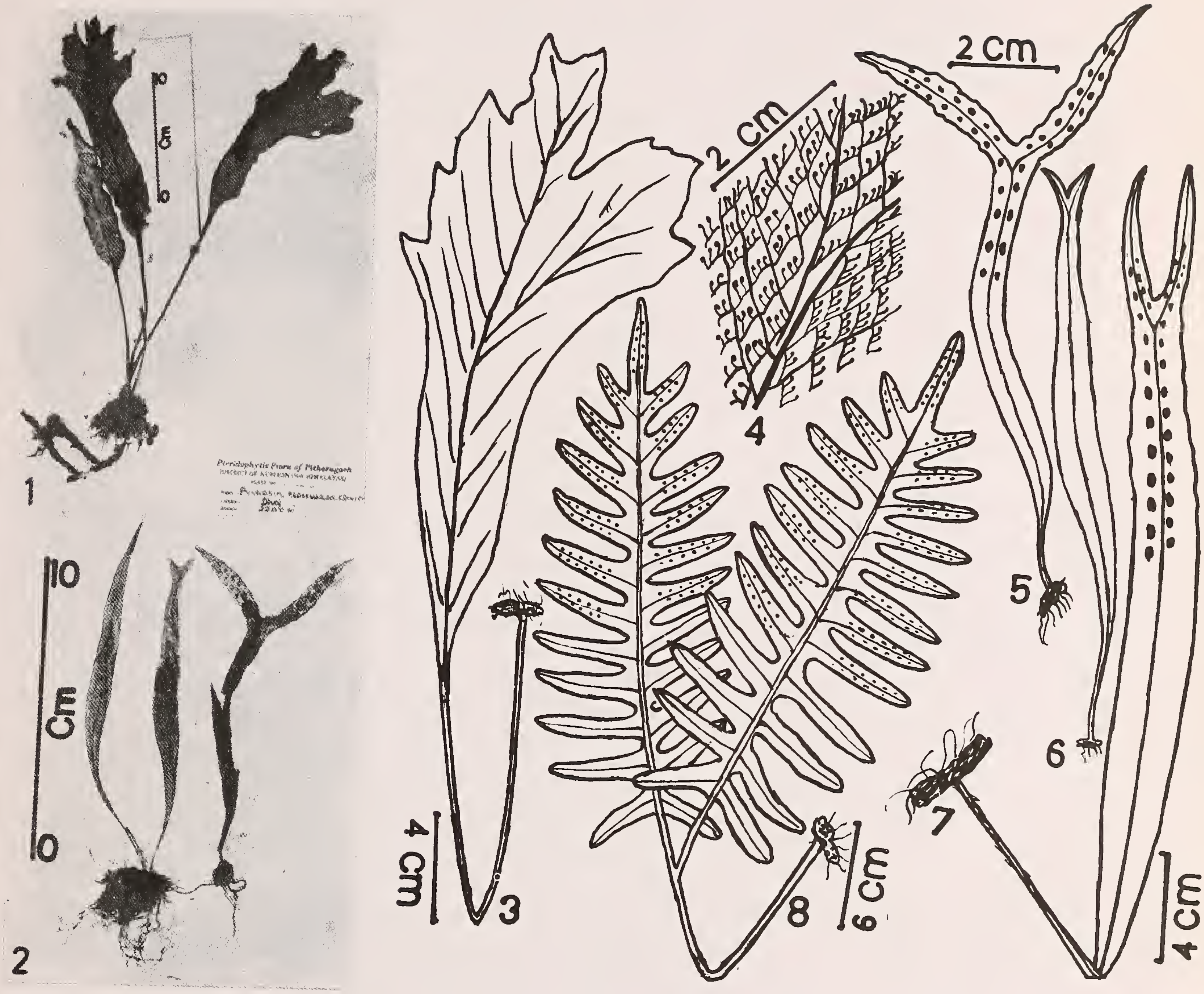
Copeland, E.B. (1947): *Genera Filicum* Chronica Botanica, Waltham Mass. p. 179.

Holttum, R.E. (1954): A revised flora of Malaya vol. 2: Ferns of Malaya. Govt. Printing office, Singapore. p. 142.

Kashyap, S.R. & Mehra, P.N. (1934): Dichotomous branching in the leaves of *Pleopeltis simplex* Sw. *Curr. Sci. 3:* 203.

Nayar, B.K. (1970): A phylogenetic classification of homosporous ferns. *Taxon 19:* 229.

Nayar, B.K. & Chandra, S. (1965): Ferns of India - 15. *Pyrrosia* Mirbel. *Bull. Nat. Bot. Gdns. Lucknow 117:* 1.



Figs. 1-8. Forking of fronds in ferns
Figs. 1, 3, 4. *Pyrrosia flocculosa*. 1 &3. forked lamina apices; 4. venation showing detached vein. Figs. 2, 5, 6. *Lepisorus tenuipes*, 2. dichotomously branched lamina; 5 &6. dichotomously branched lamina apices. Fig. 7. *L. scolopendrium*, dichotomously forked lamina apices. Fig. 8. *Phymatopteris ebenipes*, dichotomously branched stipe and production of two fronds.

ERRATA

Vol. 87 (1), pp. 53-61. Revised nomenclature for taxa in Wynter-Blyth's book on the butterflies of Indian region.

Page	Column	Line.	Sl. No. in Table	In place of	Read
53	left	27		generic name of the four	generic name or in names of the four
53	right	34	2	Crame	Cramer
56	left	38		*generator juldussica*	*generator f. juldussica*
56	right	32		Horsfield 1929	Horsfield 1829
57	left	33		Euselasiinae (under family)	Euselasiinae (under subfamilies)
57	right	29		come cases	some cases
58	right	28	48	*siva*	*siva* (Westwood)
59	left	42,44,46	94,95,96	195	196
59	right	4	105	*Pseudergoli*	*Pseudergolis*
60	right	7	145	Doubleday (under For)	Doubleday (under Correct)
60	left	27	3d	*Charaxes durnfordi*	*Charaxes durnfordi* Distant
60	right	27	3d	*nicholii* Distant Grose-Smith	*nicholii* Grose-Smith
60	right	28	4	*solon* Fabricius (Fabr.)	*solon* Fabricius
60	right	31	6	(Distant) Fruhstorfer	Fruhstorfer
60	right	40	38	Cramer (Moore)	Cramer
60	right	41	38a	(Felder) Fruhstorfer	Fruhstorfer
60	right	43	39a	*evelina* race *evalina* (Stoll)	*evelina* (Stoll)
60	left	48	56b	*trivena*	*trivena* Moore
60	right	48	56b	Palaearctic Moore species	Palaearctic species
60	left	50	66	Pantoporiareta	*Pantoporia reta*
60	right	50	66	*retamoorei*	*reta moorei*
60	left	51	67	*Pantoporiakanwa*	*Pantoporia kanwa*
60	right	51	67	*kanwaphorkys*	*kanwa phorkys*
61	left	5	102a	*cocles*	*cocles* (Fabricius)
61	left	6	104	*Chersonesiarahria*	*Chersonesia rahria*
61	left	10	142	*sinha*	*sinha* (Kollar)
61	right	10	142	*sinha* (Kollar) (Kollar)	*sinha* (Kollar)

Vol. 87 (3) New call record of greenbreasted pitta. p. 453 line 14. For '3-5 interval' Read '3-5 seconds interval'

Vol. 87(2) The voice of the kora. p. 293 line 26. For 'practice' Read 'preface'

Vol. 86(3) pp. 417 and 420. Text figures have been interchanged. Figures on p. 417 illustrate a new species of genus *Anthocopa* Lepeletier and Serville. Figures on p. 420 illustrate a new species of genus *Creightonella* Cockerell

INDEX OF AUTHORS, MISCELLANEOUS NOTES

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BIRDS

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August 1991 Vol. 88 No. 2

THE HOME RANGE OF ELEPHANTS AND ITS IMPLICATIONS FOR MANAGEMENT OF THE MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU[1]

AJAY A. DESAI[2]

(With four text-figures)

INTRODUCTION

The home range of elephants has been extensively studied in Africa, covering habitats ranging from deserts (Viljoen 1989) to tropical forests (Merz 1986). In Asia, home range has been studied in the Malaysian rain forest (Olivier 1978) and deciduous forests in south India (Sukumar 1985 and present study). Home range sizes vary depending on the habitat types. In Africa, home range sizes of 14 to 52 sq. km were reported for Manyara (Douglas-Hamilton 1972 as cited by Viljoen 1989) and 1763 to 2944 sq. km for the northern Namib Desert region of Kaokoveld (Viljoen 1989). In Asia, home range sizes varied from 32.4 to 166.9 sq. km for the rain forests in Malaysia (Olivier 1978); in south India from 105 and 115 sq. km for clans and 170 to 320 sq. km for adult bulls in deciduous forests (Sukumar 1989) and 124.3 sq. km and 156 sq. km for two female groups in primary and secondary evergreen forests (Easa 1988).

Though there have been many studies on home ranges, few have attempted to develop specific recommendations for managers. In this paper the data on elephant movements collected during the project on the ecology of the Asian elephant *Elephas maximus* in the Mudumalai Sanctuary in Tamil Nadu are being used to develop management recommendations for the study population. While this is mainly aimed at the managers of the Mudumalai Wildlife Sanctuary and the adjoining areas in Tamil Nadu, Karnataka and Kerala, the recommendations might also prove relevant to other areas in India.

STUDY AREA

The Mudumalai Wildlife Sanctuary (W.S.) is located between 11°30' and 11°39'N and 76°27' and 76°43' E, in the Nilgiris district, Tamil Nadu. The sanctuary covers an area of 321 sq km and lies at the tri-junction of three states, Tamil Nadu, Karnataka and Kerala. To the north of Mudumalai W.S. lies Bandipur Tiger Reserve and to the west the Wynnad W.S. To the east and south are Revenue Lands (private agriculture and estate lands, privately owned forests and forested land under the control of the Revenue Dept.) and Reserve Forests (Fig. 1).

[1]Accepted March 1991.

[2]Bombay Natural History Society,
Hornbill House, Opp. Lion Gate, Bombay-400 023.

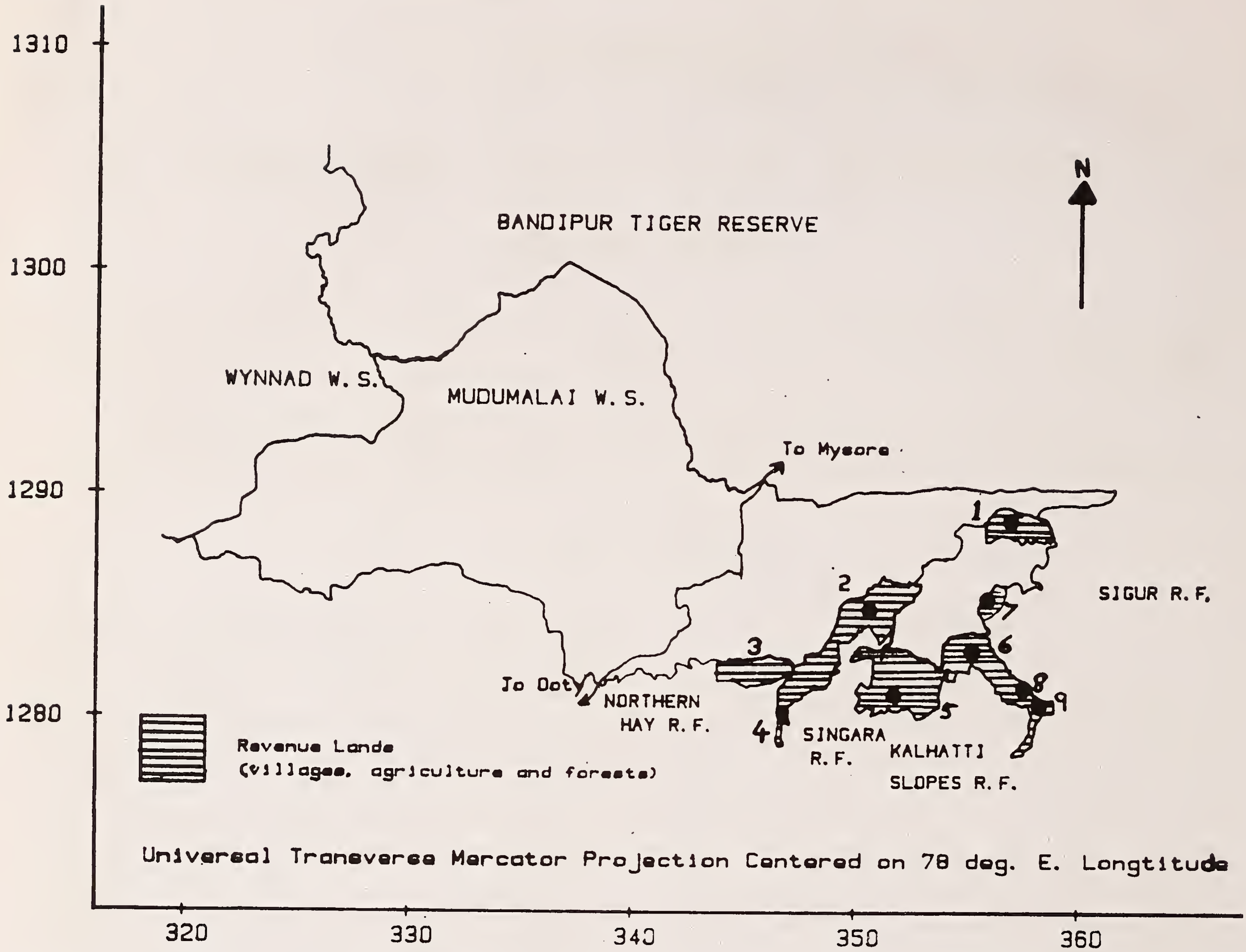

Fig. 1. Map of study area showing the locations mentioned in the text. Numbers indicate the following places: 1. Moyar, 2. Masinagudi, 3. Northern Hay Estate, 4. Singara, 5. Mavinhalla, 6. Mavinhalla, 7. Chemmanattam, 8. Chadapatti, 9. Valatottam.

Mudumalai W.S. is a part of a complex of four sanctuaries, the others being Bandipur Tiger Reserve, Nagerhole National Park (both in Karnataka) and Wynnad W.S. (Kerala). These four areas and the adjoining Reserve Forests cover over 3300 sq.km of forest and support a population of 1800 to 2300 elephants (based on Forest Dept. census figures). Together they form one of the largest single protected elephant population and elephant range in Asia. This is one of the best areas for long term conservation of elephants in Asia.

The terrain is undulating, with an average elevation of 1000 m. It is drained mainly by the Moyar river with its several tributaries of smaller rivers and streams. The western part of the sanctuary is characterised by the frequent occurrence of *vayals* (swamps) at the foot of hills. Undulating terrain with poor drainage has been responsible for the formation of these *vayals*.

The rainfall varies from 600 mm to 2000 mm, with the eastern areas getting the least rainfall and the western part of the sanctuary the highest. Correspondingly, the vegetation varies from Thorn Forests in the east to Semi-

evergreen Forest in the west. The main vegetation types are Moist Deciduous, Dry Deciduous Forests and Thorn Forests (for details see Daniel *et al.* 1985).

Objectives of the Study

The study tried to find answers to the following questions, which would be important to the proper management of elephants in the study area.

1. The size of home range for clans and adult males in the study area.
2. Whether the home ranges of clans and adult males were confined only to protected areas (National Parks and Wildlife Sanctuaries) or whether they extended into areas where the home range and the habitat within, were exposed to lower protection levels. It is assumed that a protected population can be so named only if the study animals, their home range and the habitat within it, are protected.
3. The threats to the habitat within the home ranges of the study population both in terms of actual area loss and indirectly through habitat degradation.
4. The bottlenecks in the movement corridor to the Eastern Ghats.
5. The effects of the loss of threatened areas within the home ranges on the study population.
6. The possible effect of the loss of habitat in relation to the man-elephant conflict.
7. The methods of evaluation of areas that are critically important to the study population, and the management requirement for protection of these areas from loss (direct or through degradation).

Material and Methods

The study was conducted in the Mudumalai W.S. Adjoining areas in Tamil Nadu (Sigur Range and Revenue Forests) and Karnataka (Bandipur National Park) were also covered to a lesser extent. Movement patterns and home ranges of elephants were determined through visual sightings of individually identified elephants. Elephants were recognised by characteristics such as cuts and holes in the ears, shape of the tusks and hair patterns of the tail (Douglas-Hamilton and Douglas-Hamilton 1975, Moss 1988). The study animals were photographed and could be clearly identified. In this paper, the movement patterns of three clans (codes LBF, RDC and HCF) and three adult males (codes CT, TPSR and RSB) have been used. A clan is defined as a group of elephants believed to be related, which showed coordinated movement (Moss 1988).

The elephant locations were analysed using the computer programme SEAS (Spatial Ecology Analysis System) developed by John Carey, University of Wisconsin, Madison, Wisconsin, U.S.A. Home ranges were calculated using minimum convex polygon method (Mohr 1947). Data were collected from June 1985 to December 1990 for all individuals except one bull (CT) which was shot in December 1986. For the purpose of evaluating administrative and management problems created by the study animals' ranging behaviour, the following four administrative areas were considered.

National Park (N.P): An area designated for wildlife conservation, with a higher protection status than a wildlife sanctuary. Under the control of the Forest Department (Wildlife Department).

Wildlife Sanctuary (W.S.): An area designated for wildlife conservation. Under the control of the Forest Department (Wildlife Department).

Reserve Forests (R.F.): These areas are under the control of the Forest Dept., but not Wildlife Dept. Open to normal forestry operations and not legally designated as areas for wildlife conservation.

Revenue Land: Includes both forested land under private ownership and land under the control of the Revenue Department.

The extent to which home ranges of the study population overlapped different administrative areas was calculated using the SEAS programme.

Results

The home range areas ranged from 111.2 to 265.6 sq. km ($\overline{X}$ = 203.4 ± 51.7 sq. km; Table 1). Fig. 2 shows home ranges of the three clans and Fig. 3 the home ranges of three adult males. The greatest linear dimension of the home ranges are given in Table 1. With the exception of clan HCF all showed a general north-west/south-east direction along this axis. In terms of size the home ranges of the females were larger than those earlier reported (Easa 1988, Olivier 1978, Sukumar 1989). Even in the present study the home range of clan HCF has not been well defined and hence appears smaller than that of the other two clans. The home ranges of the other two clans (LBF and RDC) are likely to represent their real size in the study area.

The home range of adult male CT was well defined as this male was very easy to identify by its tusks. Though data were collected over only a short period its home range size is large. Home range sizes for males also can be taken to represent their minimum sizes required for these animals.

It can be seen from Figs. 2 and 3 that most of the home ranges extend beyond the boundary of Mudumalai W.S. The extent to which home ranges extend into different administrative areas are given in Table 2. For the study animals, the percentage of their home range extending into Reserve forests ranged from 0% to 13.4% ($\overline{X}$ = 6.8% ± 4.8%), and in the case of Revenue Lands (forest) from 0% to 14.2% ($\overline{X}$ = 8.7% ± 4.8%). In addition all the study animals ranged into Bandipur N.P. (range 3.2% to 59%) and one clan (LBF) had 6.4% of its home range in Wynnad W.S. With the exception of clan RDC all other study animals ranged outside the protected areas. The home ranges of all (except clan RDC) are exposed to the threat of habitat loss. Only one study clan, RDC, can be said to be fully protected. Other clans and adult males have only a part of their home ranges within protected areas.

There are no bottlenecks or threatened corridors between Mudumalai W.S. and the two adjoining protected areas. Bandipur N.P. and Wynnad W.S.

The most important factor is that the elephant population of Nagerhole N.P., Bandipur Tiger Reserve (N.P.), Wynnad W.S. and Mudumalai W.S. have a link to the Eastern Ghats population through Sigur R.F. There are elephants resident in Sigur R.F. on the eastern boundary of Mudumalai W.S. These range into Mudumalai W.S. mainly during the wet season and in the dry season they move into the Moyar valley. Sukumar (1989) has also recorded elephants from the Eastern Ghats moving into Moyar valley during the dry season. It is here

TABLE 1

SUMMARY OF DATA AND HOME RANGE SIZE OF FIVE ELEPHANTS IN MUDUMALAI W.S. FOR THE PERIOD 1985/86 TO 1990/91

Elephant identification	Period of observation (months)	Home range size (sq.km)	GLD	Direction along GLD	No.of records (n)	Unit
LBF	69.0	232.0	36.7	313°/133°	257	Clan
HCF	60.5	111.2	15.0	252°/ 72°	60	Clan
RDC	56.5	265.6	21.7	286°/106°	56	Clan
RSB	65.5	199.7	24.8	296°/116°	209	Adult male
CT	18.5	243.4	30.5	285°/105°	103	Adult male
TPSR	51.3	168.2	19.9	297°/117°	53	Adult male

GLD = Greatest linear dimension of home range.

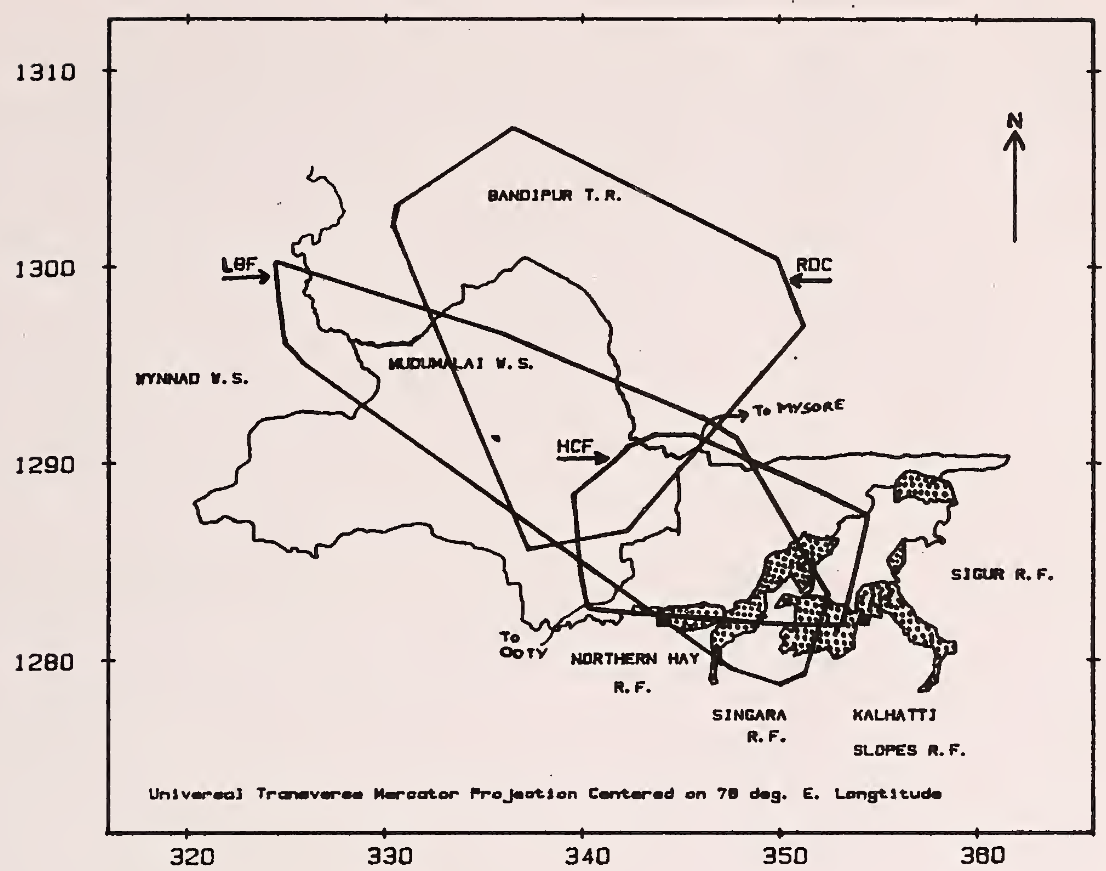

Fig. 2. Home range of three clans (LBF, RDC and HCF).
Stippled area indicates Revenue Lands (includes villages, agriculture and forests).

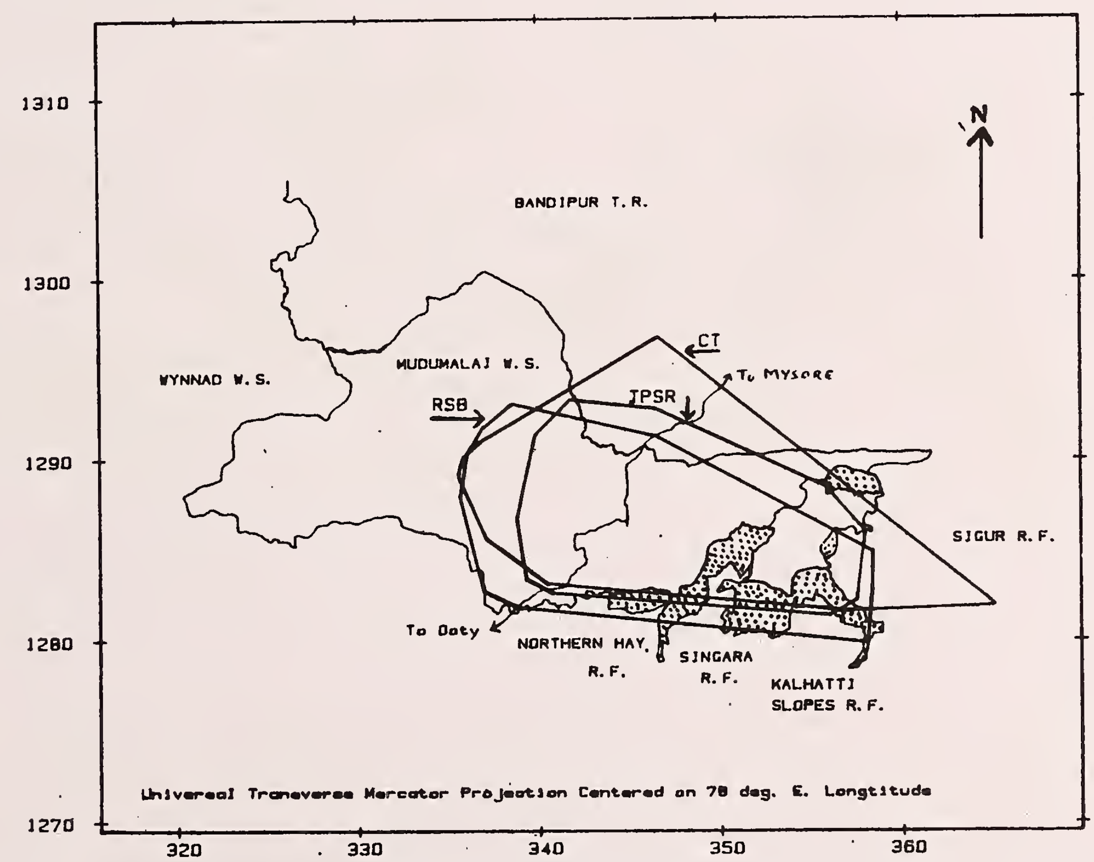

Fig. 3. Home range of three adult males (CT, RSB and TPSR). Stippled area indicates Revenue Lands (includes villages, agriculture and forests).

TABLE 2

PERCENT OF HOME RANGES LYING WITHIN DIFFERENT ADMINISTRATIVE AREAS

Identification	Mudumalai W.S.*	Bandipur N.P.**	Wynnad W.S.***	Reserve Forests*	Revenue Land*
LBF	69.3	11.6	6.4	4.6	7.0
HCF	79.8	3.8		3.5	12.9
RDC	41.0	59.0	—	—	
RSB	70.3	3.2	—	12.3	14.2
CT	59.4	20.2	—	13.4	7.0
TPSR	71.0	10.8	—	7.0	11.2

*=Tamil Nadu **=Karnataka ***=Kerala

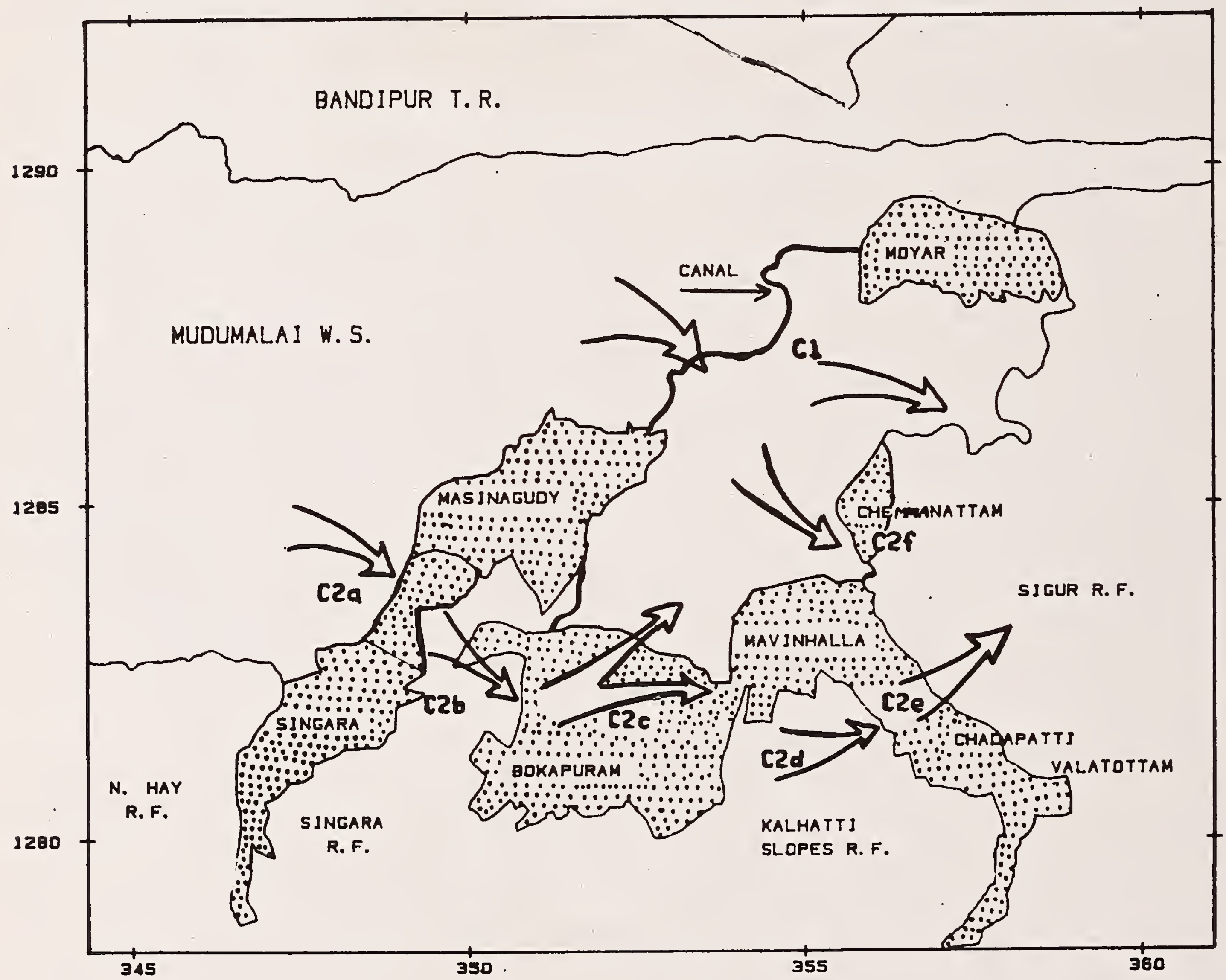

Fig. 4. Corridors between Mudumalai W.S. and Sigur R.F. Arrows indicate routes used by elephants to move into Sigur R.F. They also move back into Mudumalai W.S. along the same routes. Alphanumeric code represent the following corridor areas. C1. Canal between Masinagudi and Moyar villages, C2a. Singara estate land (forested) between Masinagudi and Singara villages, C2b. Singara R.F., C2c. Revenue land between Bokkapuram village and Mudumalai W.S., C2d. Kalhatti Slopes R.F., C2e. Revenue land between Mavinhalla and Chadapatti villages, C2f. Revenue land between Mavinhalla and Chemmanattam villages.

that the elephants from the Western Ghats and Eastern Ghats mix. Thus the main corridor between the Western Ghats and Eastern Ghats is the Sigur R.F. on the Western Ghats side.

There are two routes (corridors) between Mudumalai W.S. and Sigur R.F. (Fig. 4). The first route is between Moyar and Masinagudi villages. This area lies entirely within the Mudumalai W.S. There is a canal running between the two villages (C1 in Fig. 4) and at present elephants can easily cross it.

On the other route there are a series of corridors forming a narrow strip running along the base of the Nilgiri mountains.

(a) The most crucial one is between Masinagudi and Singara villages. This is a very narrow strip of forest land owned by the Singara Estate (C2a in Fig. 4).

(b) From the Singara estate land (C2a) the elephants can move into Singara R.F. This R.F. also acts as a corridor (C2b in Fig. 4).

(c) From Singara R.F. they can move either into the sanctuary or through the Revenue Land (forested) north of Bokkapuram village. These revenue lands act as yet another corridor (C2c in Fig. 4).

(d) The elephants can move further east into the Kalhatti Slopes R.F. (C2d in Fig. 4).

(e) The Revenue Lands (forested) between Mavinhalla and Chadapatti villages form the last corridor between Kalhatti Slopes R.F. and Sigur R.F. (C2e in Fig. 4).

(f) Another corridor exists between Mavinhalla and Chemmanattam villages. This again is Revenue Land. At places where there is direct connection between the Sanctuary and Reserve Forest, the fencing of the Nehru Ecological Park acts as a barrier (C2f in Fig. 4).

Discussion

The size of the home ranges indicates that large areas are required to support elephants in the study area. At present the complex of protected areas (Nagerhole N.P., Bandipur N.P., Mudumalai W.S. and Wynnad W.S.) is large enough to support several clans. But even now there are clans within these protected areas which range outside and are not in the true sense fully protected, i.e. a part of their range can be lost.

The loss of area could be through direct loss (conversion to non-forest use or by fencing off) or indirectly through habitat degradation (cattle grazing and other human activities). If such a loss were to occur the Revenue Lands (forested) would be the first to go. These together constitute 7% to 14.2% of the study animals' home ranges (except for clan RDC, which does not use these areas). The best way of assuring the long term survival of these threatened habitats is to convert them into Sanctuaries or National Parks, where feasible.

Though the four protected areas together hold a large elephant population the Minimum Viable Population (MVP) estimated for the area in an earlier study was below 500 (Daniel *et al.* 1987). This was due to selective poaching of males till the mid 1980s. The low male numbers effectively bring down the MVP. This problem can be offset by having a genetic link with another population. The study population has a link with the Eastern Ghats population, through a corridor through the Sigur RF. However, there are several bottlenecks in this corridor. These need to be specially protected. The bottlenecks between Mudumalai W.S. and the Sigur R.F. have been outlined in the results section and are shown in Fig. 4.

In addition to their role as corridors these areas also allow free movement to elephants during their seasonal wanderings. If these areas are lost then the elephants will get boxed into patches of forest and could cause considerable damage to crops, property and human lives. Even if they are not boxed into specific areas they will have to move greater distances along the agriculture border to reach their different feeding areas. For example, if the corridor between Masinagudi and Singara villages is cut off by agriculture or electric fencing (privately

TABLE 3

EVALUATION OF THE DIFFERENT ADMINISTRATIVE AREAS WITH REFERENCE TO WILDLIFE MANAGEMENT

	Protection priority (wildlife)	Management priority (wildlife)	Infrastructure for protection of wildlife	Legal status (for wildlife management)	Total (+ve) value
Bandipur (N.P.)	5	5	5	5	20
Mudumalai (W.S.)	5	5	5	4	19
Reserve Forests	3	3	2	3	11
Revenue Land (Forests)	0	0	0	1	1
Private Land (Forests)	0	0	0	1	1

Score: 0 = nil, 1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high.

owned land), then clan LBF (which moves east) or clan HCF (which moves west through this corridor) will have to go right round Masinagudi village. They will come into greater conflict with man (the greater the agriculture border they have to traverse, the more will be the crop raiding). Similarly the loss of any of the other corridors mentioned in the results section will lead to an escalation of the man-elephant conflict.

The loss of areas outside the sanctuary will adversely affect the study population in two ways. Firstly, there will be the direct loss of a part of the home range. This would also mean that the study population will spend more time in protected areas, thus increasing the pressure on the vegetation. Secondly, elephants originally occupying the areas lost are likely to move into protected areas and further increase the pressure on the vegetation. Loss of areas could also increase crop raiding as elephants will continue to move into areas which were once a part of their range. The increased numbers within the park and the resultant competition will also force some elephants to turn to agricultural crops for their food.

The location and size of the study animals' home ranges point to several problems with regard to the management of elephants within protected areas. As the home ranges are spread over several different administrative areas, problems can arise with their administration. As can be seen from Table 2, the home range of most animals studied extends across two states (Tamil Nadu and Karnataka) and in one case even extends into Kerala (there are clans on the western part of Mudumalai W.S. which range well into Wynnad W.S., but these are not discussed here because they have not been studied in detail). In addition, all the home ranges, except clan RDC, come under three totally different administrative agencies, namely the Forest Department, Revenue Department and private land owners. Even the Forest Dept. has two sub-departments, Wildlife and Territorial. The Wildlife Dept. again has two different levels of protection, National Park and Wildlife Sanctuary. This means that the elephants and their habitat are constantly exposed to different levels of protection depending on the legal status of the area.

To evaluate these areas with reference to elephant management, the areas were graded on a scale from 0 (nil) to 5 (very high) and the total score was given as a positive score. The areas were scored for protection and management (whether wildlife is a priority), infrastructure and legal status (whether adequate for wildlife management and protection). Table 3 gives the scores for the different areas.

The maximum possible score is 20 and the objective of management should be to increase the scores of areas with low scores. Bandipur N.P. with the maximum score rates higher than Mudumalai with a score of 19, only because it has a higher legal status as a National Park. There is a proposal to upgrade a part of

TABLE 4

THREATS TO THE HABITAT OF THE STUDY POPULATION IN DIFFERENT ADMINISTRATIVE AREAS

Columns	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Possibility of being converted to non-forest use	Cattle grazing	Fuel wood	Enclosed villages and cattle pens	Potential to increase man-elephant conflict (if lost)	Detrimental* impact on the protected elephant population (if lost)	Total (– ve) value
Bandipur (N. P.)	0	1	2	0	N.A.	N.A.	3
Mudumalai (W. S)	0	3	3	3	N.A.	N.A.	9
Reserve Forests	1	5	5	4	5	5	25
Revenue Land (Forests)	4	5	5	5	5	4	28
Private Land (Forests)	5	4	2	0	5	4	20

N.A. = Not applicable, = Protected population in this case applies to the elephants within Mudumalai W.S.

Mudumalai W.S. into a National Park. This will increase funds available to the Sanctuary (for improvement of infrastructure) but since Mudumalai W.S. has already scored the maximum 5 points in this category, no real improvement will result unless the improved legal status is used to solve the problems shown in Table 4. The areas that really need attention are the Reserve Forests, Revenue Lands (forests) and Private Forests. It is here that significant improvement can be made.

The most important point to remember about the information contained in Table 3 is that it does not show how good an area is, but rather tells the managers of Bandipur N.P. and Mudumalai W.S. where the real danger lies to a part of their elephant population. Bad management in any part of the home range will affect all the areas, irrespective of how well the other areas are managed. A typical example would be the case of the adult male CT. CT, a good breeding bull, was shot in the Reserve Forest area well outside Mudumalai W.S. It has resulted in the loss of a very good breeding bull to both Mudumalai W.S. and Bandipur N.P. Similarly, any degradation or loss of habitat or corridors in any of the areas will adversely affect the study population.

Threats in different administrative areas were also evaluated. A 0 (nil) to 5 (very high) scoring was done for different categories. Here the scoring is negative and the objective of the managers in this case would be to reduce the score as low as possible, 0 being the best (not necessarily impossible). Table 4 gives the scores for different areas.

The threat of habitat loss (column 1 of Table 4) is very real in the near future if no action is taken. This is specially true in the case of Revenue Lands. Those under private ownership are likely to be lost to elephants as soon as the owners decide to make use of that land for agriculture or even decide to fence it off using electric fences. The lands under the Revenue Dept. are also likely to be used for agriculture some time in the future, and they are also exposed to encroachment (illegal occupation). The Reserve Forests are fairly safe, but development in the long run may put a lot of pressure on them. A Sanctuary or National Park status can make them much more secure. Some basic questions that have to be looked into are the economic aspects:

(1) the revenue the area generates at present and whether it is really so high that the area cannot be converted into a Sanctuary,

foregoing the revenue, and (2) what added benefits Sanctuary/N.P. status will bring, like better protection and even revenue in the form of tourism.

In addition to the loss of habitat, the threat of habitat degradation in the form of cattle grazing, firewood collection and villages/cattle pens within the forests has also been evaluated (Table 4). Both cattle grazing and firewood collection can degrade the habitat, making it unsuitable for elephants in the long run if left unchecked. Similarly villages and cattle pens within the forests effectively deny the use of certain areas to elephants.

Columns 5 and 6 of Table 4 have been scored as not applicable to Sanctuaries and National Parks, as it has been assumed that these areas will not be lost to elephants. In all the other cases these columns contribute greatly to the negative score. With reference to elephant management a dual problem is being faced, namely protecting the elephant and its habitat and the reduction of man-elephant conflict.

From column 7 of Table 4 the areas that are most threatened can be identified, and by looking at columns 5 and 6 the severity of loss in terms of adverse impact on elephants and in terms of increased man-elephant conflict can be gauged. From columns 1 to 4 the source and magnitude of the problem can be assessed.

Converting the Revenue and private forests to Sanctuary status will remove the threat of loss. But the problems of degradation (cattle, settlements, etc.) will continue to pose a serious threat. This threat is also faced by the Reserve Forests. Any further upgrading of status is useful only if it can reduce these problems. Management objectives and actions should be towards solving these problems.

Conclusions

This paper has attempted to highlight the management issues raised by the study of home range of elephants in and around Mudumalai W.S. The findings are also relevant to the design and management of other elephant areas. Some of the critical problems and recommendations that are identified by this study are given below.

1. The boundaries of sanctuaries and other protected areas follow administrative boundaries. These rarely take into account the home ranges of animals, mainly because such information is not available for most areas which are to be protected. This flaw in design should be corrected as and when the necessary information becomes available.

2. For conservation purposes a population should be considered to be living in a protected area only if its entire home range comes under the protected area (e.g. female RDC, whose entire home range lies within the protected areas of Mudumalai and Bandipur (Fig. 2). In case of populations which range outside the protected area as part of their normal seasonal movement, the protected area should be extended to cover the entire range, or these should not be treated as living in protected areas (e.g. clans LBF and RDC, and males RSB and TPSR).

3. The absence of accurate information on ranging behaviour is definitely a drawback for designing and managing elephant areas. Studies on ranging behaviour should be taken up. Radio telemetry is by far the best and the most accurate means of studying ranging behaviour.

4. The villages like Masinagudi, Moyar, Singara, Mavinhalla, etc. are growing rapidly and will put a lot of pressure on the surrounding forests. If action is not taken to stop habitat degradation and loss soon, most of the corridors and feeding areas around these villages will be lost. This will lead to severe man-elephant conflict.

5. The areas mentioned as corridors are very critical to maintain the man-elephant conflict at its present low level. Any loss of these corridors will lead to an escalation of this con-

flict. It will also have a negative impact on one of the most viable elephant populations in Asia. The key corridors are:

(a) Between Masinagudi and Moyar villages; here the canal cuts right across the path. At present elephants can cross it easily. Any modification to the canal should have facilities to allow elephants (and other wildlife) to cross the canal at several points.

(b) The strip of forested land between Masinagudi and Singara village (owned by the Singara Estate) should be acquired by the Forest Department.

(c) Revenue Land (forested) which act as corridors are:

(i) Between Singara R.F. and Kalhatti Slopes R.F. and to the north of Bokkapuram.

(ii) Between Mavinhalla and Chadapatti villages.

(iii) Between Mavinhalla and Chemmanattam villages. These revenue lands should also be acquired by the Forest Department.

(d) Reserve Forests which act as corridors are Singara R.F., Kalhatti Slopes R.F. and Sigur R.F., Sigur being the most important.

The Sigur and Singara Ranges along with Mudumalai W.S. are part of a single ecosystem which forms a vital part of the elephants' range in the Western Ghats. It would be very useful to convert these areas into a sanctuary, especially taking into account the limited revenues they now generate.

6. Departmental (Forest) development within the elephants' range should take into account the requirements of elephants. Fencing (electric) for habitat improvement should be done only in areas where it will not deny elephants access to critical areas or hamper normal seasonal movement. Barbed wire or chain-link fencing should not be erected in areas of regular elephant use or paths as these will be pulled down by the elephants, resulting in the loss of scarce resources (money) and at the same time serving no purpose, as cattle can get in once elephants break the fence.

Today even the protected areas are under considerable pressure, so the revenue and private forests will be lost sooner or later if they cannot be brought under protection soon. Their loss will not only lead to a severe increase in the man-elephant conflict, but will also have an adverse impact on one of the best elephant populations in Asia.

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References

Daniel, J. C., Sivaganesan, N., & Desai, A.A. (1985): The study of some endangered species of wildlife and their habitat - The Asian Elephant. Annual Report 1985. Bombay Natural History Society, Bombay.

Daniel, J. C., Desai, A.A., Sivaganesan, N., & Ramesh Kumar, S. (1987): The study of some endangered species of wildlife and their habitats - The Asian

Elephant. Report October 1985 to September 1987. Bombay Natural History Society, Bombay.

Douglas-Hamilton, I. (1972): On the ecology and behaviour of the African elephant. D.Phil. thesis, University of Oxford, Oxford. Not seen in original, but has been cited in other papers.

Douglas-Hamilton, I. & Douglas-Hamilton, O. (1975): Among the Elephants. Collins and Harvill Press, London.

Easa, P.S. (1988): Movement pattern of Asiatic elephant, *Elephas maximus* in Perambikulam Wildlife Sanctuary, Kerala. Kerala Forest Research Institute, Research Report 54 (Summary).

Merz, G. (1986): The status of the forest elephant *Loxodonta africana cyclotis*, Matchie, 1900, in Gola Forest Reserve, Sierra Leone. *Biol. Conserv. 36:* 83- 94.

Mohr, C.O. (1947): Table of equivalent populations of North American small mammals. *Am. Midl. Nat. 37:* 223-249. Not seen in original, but has been cited in other papers.

Moss, C.J. (1988): Elephant Memories. University of Chicago Press, Chicago.

Olivier, R.D.C. (1978): On the ecology of the Asian elephant. Ph. D. thesis. University of Cambridge, Cambridge.

Sukumar, R. (1985): Ecology of the Asian elephant (*Elephas maximus*) and its interaction with man in south India. Ph. D. thesis. Indian Institute of Science, Bangalore.

Sukumar, R. (1989): The Asian Elephant : Ecology and Management. Cambridge University Press, Cambridge.

Viljoen, P. J. (1989): Spatial distribution and movements of elephants (*Loxodonta africana*) in the northern Namib Desert region of the Kaokoveld, South Africa/Namibia. *J. Zool. Lond. 219:* 1-19.

A REPORT ON A HERPETOLOGICAL SURVEY OF THE SRIVILLIPUTTUR RESERVE FOREST, TAMIL NADU [1]

ANITA MALHOTRA[2] AND KATHRYN DAVIS[3]

(With a text-figure)

The reptiles and amphibians found during a six-week survey of the Srivilliputtur Reserve Forest in July and August 1987 are described. The failure of the monsoon rains created unfavourable conditions and specimen numbers were low. The report is therefore largely anecdotal. Some observations on the breeding behaviour of the frogs *Ramanella triangularis* and *Micrixalus fuscus* are described.

INTRODUCTION

The Srivilliputtur Reserve Forest is situated 40 km south of Madurai, in Tamil Nadu, south India. Its south-western boundary abuts the Periyar Wildlife Sanctuary in Kerala. There has been considerable interest among conservation-oriented bodies within India in creating a wildlife sanctuary in Tamil Nadu which would include the Srivilliputtur Reserve Forest (Johnsingh 1984).

Dry deciduous forests cover the eastern and lower altitude slopes, and are inhabited by the last remaining breeding population of the Indian giant grizzled squirrel *Ratufa m. macroura*. The higher valleys and peaks to the west, which receive higher rainfall, have moist deciduous and moist evergreen forests. However, the fauna of this, more inaccessible, part of the Reserve Forest is not well known. This survey was carried out at the invitation of the Wildlife Association of Ramnad District (WARD), and took place during the period 19 July to 22 August 1987. It was almost entirely confined to the central part of the Reserve Forest (i.e. to moist shola forest between 1060-1690 m) and areas of grassland and scrub adjoining the forest at higher altitudes.

Other objectives of the project included recording amphibian breeding calls, and an attempt to relocate the rare endemic frog *Melanobatrachus indicus* (Beddome), not seen since its original collection in 1898. Our time in the field was planned to commence after the onset of the south-west monsoons. Although Srivilliputtur receives the major part of its annual rainfall from the north-east monsoon (October-November), it also receives heavy rain from the south-west monsoon (May-June), and thus conditions were expected to be moist and well suited to our project. However, in 1987 the south-west monsoon failed almost completely in most of the Indian subcontinent. We were therefore only successful in recording the calls of three species of frogs: *Ramanella triangularis, Micrixalus fuscus*, and *Rana beddomii*. Details of these species are presented later. The first two recordings are breeding calls, and the last (this species was not breeding at the time) is an alarm call.

The recordings have been deposited with The British Library of Wildlife Sounds (BLOWS), 29, Exhibition Road, London SW7 2AS. *Melanobatrachus indicus* was not found. However, checklists of birds, butterflies, and mammals encountered in the field were also prepared and are reported elsewhere (Malhotra *et al.* 1988). Because of the low rainfall, specimen numbers were low, and hence this report is largely anecdotal. It is hoped that this will nevertheless contribute something of significance to herpetological knowledge in India.

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Material and Methods

We intended to use a number of methods, including active searching, and a variety of traps [e.g. pitfall traps, pipe traps, (Lohoefner and Wolfe 1984) and drift fences]. However, we had only one pipe trap in the field, and it did not prove to be very successful. It is difficult to say whether this was attributable to a design fault or the reduced activity and low density of forest floor inhabitants. In general, traps of this type have low capture rates and are most fruitful if left over as long a period of time as possible. They have to be checked regularly and this can limit the sites available. Our trap was eventually damaged by a larger animal (possibly a wild boar *Sus scrofa*) which tore up the drift fence.

Systematic quadrat searching was abandoned after some initial experimentation: it was felt that because of the low density of amphibians and reptiles we would do better to concentrate on active searching, whereby we could focus on many different habitats while covering larger areas.

Our methodology involved close visual inspection of trees and shrubs up to a height of 4-5 m, a careful search of the ground, turning over litter, stones and rocks, and digging where possible. Detailed notes were made at the time of capture for each specimen: position (location and microhabitat) and behavioural notes, snout-vent lengths, tail lengths and scale counts where appropriate, and details of coloration (backed up in most cases by photographs). Only if there were any difficulties with identification, or if the specimen was of particular interest for other reasons, was it killed and preserved for examination at the Bombay Natural History Society. The conditions under which we had been granted permission did not allow for the collection of a comprehensive series of the species found, and as the emphasis of this project was very much on conservation, collection of specimens was kept to a minimum.

Sandoz MS222 (at a dilution of 1:500) was used to kill amphibians. Small (under 5 cm SVL) frogs and toads are simply dropped in, and quickly succumb. The best method is to use a screwtop jar filled almost to the brim to limit their ability to gulp air. In the case of reptiles, a solution of Nembutal was administered orally with a small paintbrush. All specimens were labelled with numbered tags, and the relevant information (date and time of capture, elevation, position, habitat, details of coloration in life) was recorded in a field notebook against that number. Amphibians were preserved in 1:16, and reptiles in 1:10 formalin solution. Some of the specimens collected are deposited with the Bombay Natural History Society.

Results

The measurements given refer to snout-vent lengths, and for snakes and lizards, the length of the tail is given in brackets. The following abbreviations are also used: F=Female. Juv.=Juvenile. It did not prove possible to sex the specimens in all cases, so this data is only given where known.

SERPENTES

Family: Uropeltidae

Uropeltis ceylanicus Cuvier

Number of specimens found: 2. Size: 57, 210 mm. Altitudinal range: 1060-1290 m. Habitat: shola. Microhabitat: both specimens were dug from at least 15 cm below the soil surface.

The head and tail of this species are very similar in appearance, both being wedge-shaped and having a lateral yellow stripe. The smaller specimen assumed a tightly coiled position, with the head underneath the coils and the tail protruding from the top. This is probably a predator avoidance strategy.

Family: Colubridae

Oligodon venustus (Jerdon)

Number of specimens found: 2. Size: no data. Altitudinal range: 1290 m. Habitat: shola.

Microhabitat: both found crossing a path through the shola.

These snakes were very vicious in disposition and delivered painful bites with their long posterior maxillary teeth. Their lack of a distinct neck, and their loose skin, made them difficult to restrain. They also employed a 'stabbing' motion of the tail, which seemed to have a conical, sharp-tipped terminal scute.

Liopeltis calamaria (Gunther)

Number of specimens found: 3. Size: 122-270 mm, mean 190.7 mm. Altitudinal range: 1290-1690 m. Habitat: grassland. Microhabitat: two specimens were found under rocks, one was caught while basking on a rock in the early morning.

A gentle and inoffensive snake.

Ahaetulla nasutus (Lacepede)

Number of specimens found: 7. Size: 482-695 mm, mean 611.4 mm (one specimen sighted, estimated total length 1000 mm). Altitudinal range: 1060-1290 m. Habitat: scrub (4 specimens) and shola (3 specimens). Microhabitat: all found in small trees or in the top fronds of *Phoenix* bushes.

Most of the specimens were caught while basking in the early hours of the morning. Some were aggressive when caught and the larger ones were capable of giving fairly painful bites. Others were docile.

Elaphe helena (Daudin)

Number of specimens found: 1. Size: 475 mm. Altitudinal range: 1290 m. Habitat: grassy ridge near the edge of shola. Microhabitat: in tall grass.

A very docile snake. Caught while basking in the early morning.

Dendrelaphis bifrenalis (Boulenger)

Number of specimens found: 1. Size: 495 mm. Altitudinal range: 1150 m. Habitat: scrub/shola boundary. Microhabitat: on ground near the waterhole.

A very docile snake. It was in the process of catching a frog near the waterhole (possibly *Rana beddomii*) when it was disturbed.

Dendrelaphis grandoculis (Boulenger)

Number of specimens found: 1. Size : no data. Altitudinal range: 1290 m. Habitat: shola. Microhabitat: was in leaf litter when caught, but had just jumped down from a small tree.

This snake had an aggressive display involving inflating the anterior part of its body, exposing the pale blue interscalar skin, and extending its bright blue tongue to its full length. However it made no attempt to strike. There was also a prominent yellow patch on its throat.

Sibynophis subpunctatus (Dumeril & Bibron)

Number of specimens found: 1. Size: 225 mm. Altitudinal range: 180 m. Habitat: dry deciduous. Microhabitat: found crossing a sandy path near a village.

A quick, alert snake, making rapid darting movements with its head. Its locomotion, as it crossed the hot sunlit path, was somewhat reminiscent of sidewinding.

Amphiesma beddomei (Gunther)

Number of specimens found: 7 adults, 2 juv. Size 129(40)-450(145) mm, mean adult size 362 mm. Altitudinal range: 1060 m. Habitat: scrub, shola. Microhabitat: 4 specimens were found by the edge of streams, the others were not near any water. One was dug out from beneath a rock.

All were gentle and inoffensive snakes. The coloration of eight of our specimens agreed well with the description in Smith (1943), varying in the amount of yellow visible, and in the distinctness of the parietal bar. However, one juvenile was completely different in coloration although it agreed well in other specific details, such as scalation. It was dark grey in colour dorsally and reddish brown ventrally. The same reddish

brown colour was present in two irregular patches on the head, a smaller one on the internasals, and a larger one on the prefrontals and parietals. Bordering this posteriorly were two white bands, curving away from each other so that they did not meet on the midline. There were two dorsolateral rows of separated reddish-brown black-edged spots extending down the body and tail. In addition, the specimens varied in the number of supralabials, one individual (otherwise similar) having a different number on either side of its head.

Macropisthodon plumbicolor (Cantor)

Number of specimens found: 1(F). Size: 350 (60) mm. Altitudinal range: 1060 m. Habitat: shola. Microhabitat: among the roots of a tree near the campsite.

Made no attempt to strike. It was found at night at the base of a tree in which there was a tree pool containing several *Ramanella triangularis*.

Boiga ceylonensis (Gunther)

Number of specimens found: 1 juv. Size: 236 (65) mm. Altitudinal range: 1140 m. Habitat: shola. Microhabitat: in accumulated leaf litter in dry pool on stream bed.

This snake was found during the day in leaf litter, although this species is nocturnal and arboreal. It assumed an 'S' shaped defensive posture and struck several times, but on handling became docile.

Family: VIPERIDAE
Trimeresurus macrolepis Beddome

Number of specimens found: 1 adult, 1 juv. Size: 137(30), 215(50) mm. Altitudinal range: 1140-1515 m. Habitat: shola. Microhabitat: the adult specimen was found on a low bush near the path, and the juvenile was found in leaf litter.

It has been suggested that juvenile pit vipers of other species use the tips of their tails as 'bait' to attract prey. In this context the following observations are of interest. The tip of

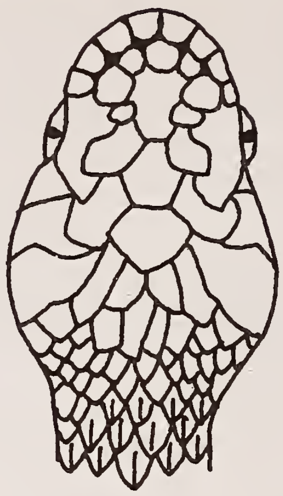

Fig. 1. Unusual head scalation of a juvenile *Trimeresurus macrolepsis*. Note the extra-interorbital scales.

the tail in the juvenile specimen was greyish-white for about one-sixth of its length, and a further three-sixth was banded olive green and brown, and was thus visually distinct from the rest of the body which is bright green. It was observed to coil up with the tip of the tail protruding, and wriggled in a way that suggested worm imitation. The head scalation of this specimen differed considerably from Smith's description, having a number of extra scales (Fig. 1).

Trimeresurus malabaricus (Jerdon)

Number of specimens found: 2. Size: ?, 1050 mm. Altitudinal range: 1060-1210 m. Habitat: shola. Microhabitat: on branches of small trees/shrubs. One was 4 m and the other 1.3 m from the ground.

Both specimens were found during the day and were asleep. We did not disturb the one found closer to the ground, and it did not wake in spite of one of us accidentally brushing against the sapling on which it was sleeping.

In addition to the above specimens we also found the recently sloughed skins of two snakes. If in reasonable condition and state of completeness, it is possible to identify some snakes on the basis of sloughed skin. We were able to identify one of the skins as *Ptyas mucosus* (Linn.), the common rat snake. It was found in grassland, and was of a large diameter. It was estimated (by Chokkalingam, the Irula snake-

catcher who accompanied us), to have been shed four days previously. The second skin was not very complete, the head forward of the parietals being missing. However, the parts which remained were intriguing. Scales were in 21 rows, and the vertebral scales were hexagonal and strongly enlarged. The diameter was small. The condition of the vertebrals should allow the possibilities to be narrowed down considerably. However, we cannot find a species that has this combination of characters, which is known to occur in southern India. If anyone has any ideas on the identity of this snake, we will be very interested in hearing from them.

SAURIA

Family: GEKKONIDAE

Dravidogecko anamallensis (Gunther)

Number of specimens found: 2. Size: 37, 42 mm. Altitudinal range: 1060 m. Habitat: shola. Microhabitat: on tree trunks in the clearing.

Hemidactylus maculatus Dumeril & Bibron

Number of specimens found: 1. Size: 100 mm. Altitudinal range: 1150 m. Habitat: scrub. Microhabitat: on the outer wall of the Rest House.

The tail had been regenerated.

Cnemaspis kandiana (Kelaart)

Number of specimens found: many. Size: F, 33 (29) mm. Altitudinal range: 1150 m. Habitat: scrub/shola boundary. Microhabitat: on outer wall of Rest House.

Many of the females were gravid. The female whose measurements are given above had two eggs 5.8 mm long. The coloration agrees with Smith's description except that the head is yellowish. This was especially bright on the gular region and the rims of the eyes, and was present in both males and females.

Family: AGAMIDAE

Draco dussumieri Dumeril & Bibron

Number of specimens found: 1. Size: No data. Altitudinal range: 1150 m. Habitat: scrub/shola boundary. Microhabitat: on the concrete wall surrounding the water hole.

Described as "entirely arboreal, never descending to the ground except for breeding purposes" (Murthy 1985). Possibly the unusual dryness of the season induced it to descend to the waterhole. Our first attempt to catch it resulted in its jumping down from the raised edge of the waterhole to the base of a tree, extending its side flaps very slightly. When released it took to the trees extremely rapidly.

Calotes versicolor (Daudin)

Number of specimens found: 1 M, 2 F, 2 juv., but many more sighted. Size: Juv. 66 (183), 70 (210) mm; F 90 (218), 80 (190) mm; M 115 (237) mm. Altitudinal range: 1060-1150 m. Habitat: scrub/shola. Microhabitat: the male was found in a prominent position on a tree trunk. The females and juveniles were all found near the ground, on rocks, bushes and tree trunks.

The sexes are very dimorphic. The male was seen regularly in the same one or two trees near the campsite. Both females were gravid. One of the juveniles had recently sloughed and its coloration was very intense and distinct.

Calotes grandisquamis Gunther

Number of specimens found: 4 M. Size: 108 (250)-147 (345) mm. Altitudinal range: 1060-1210 m. Habitat: shola. Microhabitat: two were found on the trunks of tall trees. One was basking in a small tree, and one was found drinking at the waterhole.

A very colourful lizard. One male, when first seen, had an intense orange-red gular region, but on capture this had faded to a faint orange flush as seen in the other specimens.

Psammophilus dorsalis (Gray)

Number of specimens found: 5 M, 1 F, 2 juv.; but many more seen, especially displaying males. Size: M 88-107 mm, mean 98 mm; F, no data; juv. 34(67), 41(86) mm. Altitudinal range:

1150-1515 m. Habitat: expanses of rock. Microhabitat: most found basking on rocks, or in the case of males, while displaying on rocks.

A very agile species, difficult to catch as they quickly retreat into rock crevices. The male display consists of push-ups and head bobs. They are extremely brightly coloured while displaying, having bright red cheek stripes and a yellow/orange stripe down the back. However, they quickly revert to a cryptic greyish mottled pattern on being disturbed.

Psammophilus blanfordanus (Stoliczka)

Number of specimens found: 3 M 2 F, 1 juv.; but many more seen. Size: M 74(135) mm; F 74, 82 mm. Altitudinal range: 1060-1290 m. Habitat: expanses of rock. Microhabitat: on or under slabs of rock.

The larger female was gravid.

Family: SCINCIDAE

Mabuya carinata (Schneider)

Number of specimens found: 3 M, 1 F; more seen but not caught. Size: M 62 (89)-110 (200) mm, mean 90.7 mm; F 62 (73) mm. Altitudinal range: 910-1150 m. Habitat: scrub, shola. Microhabitat: basking on rocks, or in leaf litter.

The males were in breeding colours: the flanks and the sides of the jaws were red or orange-red in colour.

Mabuya macularia (Blyth)

Number of specimens found: 1 M 2 F. Size: M 65 mm; F 62 (79), 70 (62) mm; mean 65.7 mm. Altitudinal range: 910-1150 m. Habitat: shola, scrub. Microhabitat: leaf litter.

The male was in breeding coloration: a salmon-pink tinge extending from the chin over the ventral surface to a line between the front legs; and extending to the rostral and the first two supralabials on the upper jaw. One of the females found corresponded in coloration to a form whose range is described by Smith (1943) as "Peninsular India north of 12 degrees north".

Leiolopisma travancoricum (Beddome)

Number of specimens found: 4 juv., 4 adults; many more seen. Size: Juv. 29(40) mm; Adults 50-57 (tails damaged), mean 54.75 mm. Altitudinal range: 1140-1290 m. Habitat: shola. Microhabitat: leaf litter, under stones or rotting logs, rocks on wet stream margins.

Juveniles had metallic blue tails. This colour is restricted in adults to a blue sheen on the ventral surface of the tail. The size of these skinks is somewhat larger than described by Smith (1943). They were very abundant in one particular site during the earlier part of our study period, but virtually disappeared later. For example, 16 specimens were recorded during a two-hour search of the forest on either side of the path to the stream on 3 August, yet on later occasions we found none at all. Another observation was that on our first few visits to this site, these skinks were extremely abundant on the rocks and banks of the stream, especially juveniles. However, on later occasions we rarely saw any juveniles here.

Riopa punctata (Gmelin)

Number of specimens found: 4 juv., 5 adults. Size: Juv. 45(52)- 63(76) mm, mean 53.5 mm; Adults: 55(36)-62(65) mm, mean 64.75 mm. Altitudinal range: 1060-1290 m. Habitat: scrub, grassland. Microhabitat: under stones or in grass tussocks in which they had taken cover.

Juveniles were defined as those specimens still having traces of red on the tail. The smaller specimens had very intense orange-red tails, while the larger ones had a faint reddish tinge. The 'adults' had no trace of red at all. One of the specimens (Field No. 24/7/A), identified as being of this species by the BNHS, is aberrant in that it had no trace of red in spite of being smaller than some of the 'juveniles' found. It was also much darker than the others, and had a tail which was significantly shorter than its body, with no sign of damage. In his description of this species, Smith (1943) states that the tail

is longer than the body, and this was the case in all the other specimens found. It had a mid-body scale count of 28, which Smith states to be rare in this species. It was also the only specimen to be found in an area of scrub rather than in grassland.

Family: VARANIDAE
Varanus bengalensis (Schneider)

Number of specimens found: 1 juv., 3 adults sighted. Size: Juv. 113 (186) mm; adults: estimated total lengths up to 1000 mm. Altitudinal range: 1210-1820 m. Habitat: scrub, grassland. Microhabitat: the juvenile was found under a pile of rocks.

In addition to the specimens seen, we also found monitor droppings, containing egg shells, many insect remains (mostly legs), and some mammal hair. One of our party encountered an adult monitor at close range while taking photographs of birds. While foraging, it came right up to his feet and even licked his boots before retreating.

ANURA
Family: RANIDAE
Rana diplosticta (Gunther)

Number of specimens found: 7. Size: 17-27 mm, mean 20.16 mm. Altitudinal range: 1140-1515 m. Habitat: shola. Microhabitat: most were found in leaf litter in the immediate vicinity of water, but one was found under a rotten log, far from any streams.

The specimen found under a log had a somewhat flattened appearance and was very sluggish.

Rana temporalis (Gunther)

Number of specimens found: many. Size: 15-53 mm, mean 45.75 mm. Altitudinal range: 910-1140 m. Habitat: shola. Microhabitat: all were found in the vicinity of water.

This species was more common at lower elevations. They were present in large numbers in pools remaining in the rocky river beds. The smallest specimen found had a tail about half its body length. Only a few were found at higher elevations.

Rana beddomii (Gunther)

Number of specimens found: many. Size: 14-43 mm, mean 28.4 mm. Altitudinal range: 1060-1515 m. Habitat: shola. Microhabitat: some were found near streams, others in leaf litter far from streams. One was found under a rotten log, one in a tree pool about 20 cm from the ground.

This was the commonest species present. They frequently squirted out the contents of the bladder when picked up. A small proportion were darker brown with a light vertebral stripe.

Micrixalus fuscus Boulenger

Number of specimens found: many. Size: 16-27 mm, mean 21 mm. Altitudinal range: 1140-1515 m. Habitat: shola. Microhabitat: always found near water, on rocks on the bank and in mid-stream.

A very variable species. Most specimens had a lighter V-shaped band on the dorsal surface. In one case a frog was seen with a bright yellow V-shaped band, but on being pursued, the colour faded to a light brown. Some males of this species were observed displaying in a seepage area of the stream (see below for details). The breeding call of this species was also recorded.

Nyctibatrachus major Boulenger

Number of specimens found: 8. Size: 21-41 mm, mean 33.3 mm. Altitudinal range: 1140-1515 m. Habitat: shola. Microhabitat: all found in water.

About five frogs were present in the same small pool off the main flow of the stream. They were lined up along the edge, clinging to the vertical sides of the pool with their heads just above water. They were not at all wary of being approached.

Nannobatrachus beddomii Boulenger

Number of specimens found: 3. Size: 10-15 mm. Altitudinal range: 1515 m. Habitat: shola.

Microhabitat: on the edge of the stream.

The smallest specimen had a tail 16 mm long, and the other two had vestiges of a tail. Two colour forms were present: a pale tan (one specimen), and a dark brown (exhibited by the other two specimens).

Family: RHACOPHORIDAE
Philautus variabilis (Gunther)

Number of specimens found: 7. Size : 17-19 mm, mean 18.2 mm. Altitudinal range: 1140-1515 m. Habitat: shola. Microhabitat: leaf litter, some near streams but others far from any bodies of water.

Almost all were pale fawn in colour when caught, but on being kept in a container with moisture, became much darker. They all had a turquoise tinge on the flanks and between the eyes, and the upper eyelid, when fully retracted, revealed a brilliant turquoise stripe above the eye. This, and other details of the coloration of our specimens, corresponds better with the description of *Philautus signatus* than of *P. variabilis* (Inger *et al.* 1984); however, the specimens were identified as the latter by the BNHS.

Family: BUFONIDAE
Bufo melanostictus Schneider

Number of specimens found: 1 F. Size: 105 mm. Altitudinal range: 1060 m. Habitat: grassland on the edge of the shola. Microhabitat: in tall grass.

It inflated itself when handled. It was found on a rainy day in the afternoon; this species is normally nocturnal except in the breeding season.

Family: MICROHYLIDAE
Ramanella triangularis (Gunther)

Number of specimens found: 6. Size: 22-26 mm, mean 24.2 mm. Altitudinal range: 1060-1140 m. Habitat: shola. Microhabitat: one was found under the bark of a log within a few metres of the edge of a stream, and the others were all found either in, or climbing up to a small tree pool about 2.75 m from the ground.

The specimen found under bark of a log was very torpid, and much thinner than the active specimens found in the tree pool. This was within a few metres of our campsite, so we were able to make some observations of breeding behaviour. The breeding call of this species was recorded. An additional point of interest is that specimens seemed resistant to the anaesthetising action of MS222. A couple of specimens were left in the solution for a considerable time but showed no sign of succumbing. The same solution was subsequently used to dispatch specimens of other species, and proved to be effective for these.

Tadpoles: Several tadpoles were collected. These have been identified as follows: 1) *Nyctibatrachus* sp.: six, at different stages of development. The largest were almost fully metamorphosed but still retained a tail longer than body length. These were all collected from the same site, and several were taken from the same pool as the adult *Nyctibatrachus major* specimens. It would therefore seem likely that these tadpoles are *N. major.* 2) *Rana* sp.: one. 3) *Micrixalus* sp.: one, from river where adults of *M. fuscus* were abundant.

OBSERVATIONS ON BREEDING BEHAVIOUR

Micrixalus fuscus: Frogs of this species were heard calling at several different sites along the Chittar river, but a display was only seen at one site, where it was observed on several different occasions. The display consisted of stretching a hind leg upwards and backwards, with the digits spread to display the pale blue interdigital webbing. The leg was held in this position for a short time and then lowered to the ground, and finally retracted to the normal position. On some occasions the leg was only extended backwards and not upwards. Males did not usually call while displaying, and several males were seen displaying at the same time. The display took place in a seepage area near the edge of the stream. One of the displaying males was caught

and examined, and the dorsal surface of its feet was much bluer in colour than other specimens examined. In had a well developed nuptial pad on the first digit of the foreleg.

Ramanella triangularis: These frogs were first heard calling in the evening of 27 July, after heavy rain the previous night. Three males were present, and one was collected. Calling was also heard the next night, but stopped after this for a week, during which it did not rain. Calling resumed after the next heavy rain (in the afternoon of 7 August). Males began calling soon after dusk (about 1900 hrs) and called for 1-2 hours; this appeared to be the general rule. On examination it was seen that there were now four frogs, all apparently male (at least three of them were observed to call). One of the males attempted to amplex another and was repelled. None of the males had visible nuptial pads. Later the same night another frog was found climbing towards the pool. It could not be positively identified as being female, but this can possibly be inferred from its larger size and the observation that on 9 August, a pair in axillary amplexus were observed in the pool. (There was no activity on 8 August; only one frog was observed clinging to the side with its head out of water; there had been no rain that day.) The female was larger than the males present. Between 9 and 17 August there was no calling and little activity in the pool. As many as four males were observed on occasion, but appeared to be much shyer and quickly dived away. On the morning of 17 August (0530 hrs), another frog was found climbing the tree towards the pool. On the 18th, after several days of light rain, soft calling was heard at 2000 hrs. The following day they also called for several hours during the day. It was raining lightly. At this point our observations came to an end.

Conclusions

It should be noted, with regard to the conservation aims of this project, that there are many difficulties associated with assessing the status of many of the species found. Few recent reviews are available (but see Inger and Dutta 1987), and many reports are scattered in the literature and are not readily available. However, at least some of the species found here appear to be rare on a national and global scale (Dodd 1987). Given the adverse conditions encountered, it is certain that the faunal list we have compiled represents only a fraction of the species present in the Reserve Forest. Many of the species are restricted to areas of moist tropical forest and are threatened by habitat destruction. Apart from a few species exploited by man (e.g. the monitor lizard), conservation of these animals is bound up with conservation of their habitat. We therefore applaud the decision of the Government of Tamil Nadu to declare the Srivilliputtur Reserve Forest a Wildlife Sanctuary.

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References

Daniel, J.C. (1963): Field Guide to the Amphibians of Western India. Parts 1 & 2. *J. Bombay nat. Hist. Soc. 60*: 415-438, 690-702.

Daniel, J.C. (1975): Field Guide to the Amphibians of Western India, Part 3. ibid. 72: 38-54.

Dodd, C.K., jr. (1987): Status, conservation and manage-

ment. *In:* Snakes: Ecology and Evolutionary Biology. Eds. Siegel, Collins & Novak. Macmillan & Co. Ltd.

INGER, R.F. & DUTTA, S.K. (1987): An overview of the Amphibian fauna of India. *J. Bombay nat. Hist. Soc.* (Centenary Supplement): *135-146*

INGER, R.F., SCHAFFER, H.B., KOSHY, M.V. & BADKE, R. (1984): A Report on a collection of Amphibians and Reptiles from the Ponmudi, Kerala, South India. *J. Bombay nat. Hist. Soc. 81:* 406- 427, 551-570.

JOHNSINGH, A.J.T. (1984): Megamalai Wildlife Sanctuary. *Hornbill 1984(4):* 23-27.

LOHOEFNER, R. & WOLFE, J. (1984): A 'new' live trap and a comparison with a pitfall trap. *Herpetological review 15(1)*: 25-26.

MALHOTRA, A., DAVIS, K.K.D., SCOONES, T. & WOODROFFE, R. (1988): India 1987, The Final Report of the Oxford University Herpetological Expedition to South India 1987. Unpublished report.

MURTHY, T.S.N: (1985): A Field Guide to the Lizards of the Western Ghats. *Records Zool. Surv. India.* Misc. pap. No. 72:1- 51.

SMITH, M.A. (1935): Fauna of British India, Reptilia and Amphibia. Vol. II - Sauria. Taylor & Francis, London.

SMITH, M.A. (1943): ibid. vol. III - Serpentes.Taylor & Francis, London.

BURROWING ACTIVITY AND DISTRIBUTION OF *SCYLLA SERRATA* (FORSKAL) FROM HOOGHLY AND MATLA ESTUARIES, SUNDARBAN, WEST BENGAL[1]

N.C. Nandi[2] and M.K. Dev Roy[3]

(With five text-figures)

Burrowing activity and distribution of *Scylla serrata* (Forskal) have been studied from mangrove environment of Hooghly and Matla estuaries. The male-female ratio was estimated by excavating 120 burrows selected at random in Matla estuary. Population density (individuals/ sq. m) was estimated at four places in the Hooghly and Matla estuaries. Burrows were mostly located between upper mid-littoral and highest high tidal zone in the estuarine and mangrove mudflats. Most frequent ellipsoidal burrows were with single external opening (94.17%) descending downwards, straight or slightly slanting. A total of 111 crabs (44 males, 67 females) were found in 108 out of 120 burrows that were excavated. Population density varied from 0.32 to 1.2/sq. m in the Hooghly estuary, and from 0.24 to 1.20/sq. m in the Matla estuary. The length of the crab can be correlated with the diameter of the burrow.

Introduction

The marine swimming crab *Scylla serrata* (Forskal) (Crustacea: Brachyura: Portunidae), the common edible species, is found in the Indo-West Pacific region (Macnae 1968). Although considerable work has been done on the biology and fishery aspect of a number of edible brachyuran crabs, very little is known about the burrowing behaviour in portunid species. In the present study, the burrowing activity and the distribution of this species have been studied in the Hooghly-Matla estuarine system of Sundarban, West Bengal.

Earlier the burrows of some shore crabs have been described by Silas and Sankarankutty (1967) from the Gulf of Mannar and Palk Bay, and by Chakrabarti (1971,1980), Chakrabarti and Das (1983) and Bakshi *et al.* (1980) from Digha and Sundarban beaches of West Bengal respectively.

Material and Methods

The burrow structure (diameter, depth and course) of *Scylla serrata* has been studied in the Matla estuary at Nikarighata, Canning, by engaging a professional crab-fisher. Distribution and population density (individuals/sq. m) of the crabs have been observed by probing with an iron hook used for fishing crabs in the Hooghly-Matla estuaries. The number of crabs collected from burrows from six different plots has been used in estimating the population density. The various other holes in the mudflats inhabited by fiddler crabs (*Uca* spp.) and sesarmine crabs (*Sesarma* spp.) can be distinguished by their smaller size, circular shape and/or mound formation (Warner 1977). A total of 120 burrows were dug out during April-May 1986 at random from Matla estuary, Canning, to study the burrow structure and male-female distribution of the crabs occupying these burrows. The crabs were collected and measured immediately in the field.

Observations

Location of the burrow: The burrows are usually located in the mangrove swamps, estuarine mudflats, brackish water impoundments and *bheries* as well as in the rice fields of Sundarban. The freshwater dominated rice fields of Taldi and Nischintapur areas are also seen to be inhabited by this species during monsoon season. In the estuarine and mangrove mudflats,

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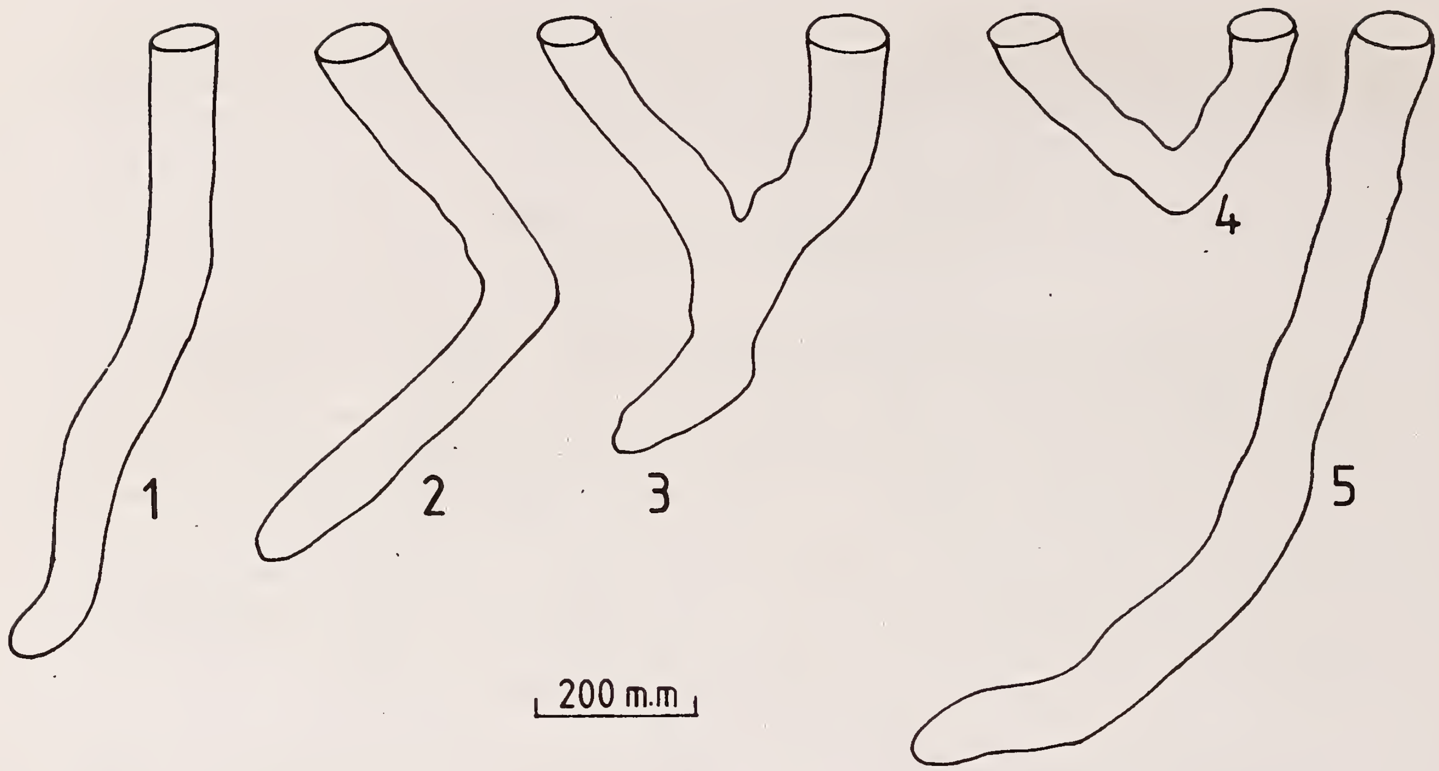

Figs. 1-5. Diagrammatic representation of *Scylla serrata* burrows. 1, 2, 5. Burrows with a single external opening, 3. Y-shaped burrows with two external openings. 4. V-shaped burrow with two external openings.

burrows were found mostly in the upper mid-littoral to the highest high tide zone. These burrows were usually located in places where tidal waters normally do not reach during fifth to seventh days of the lunar period. As such, these places which are less exposed to inundation are preferred sites for burrowing activities. Some burrows were also noticed in the flowing water channel. In the mangrove forest burrows were located close to the creek edge. In the rice fields burrows were usually found adjacent to the bund.

Burrow structure: (Figs. 1-5) Burrows are simple tunnels, descending downwards, either straight or slightly slanted. The external opening is ellipsoidal and devoid of any superstructure. The burrows have one to three openings on the surface. The burrows with two openings exhibit V- or Y-like configuration. Branching or pouch formation was not observed. The longest diameter of the burrow varied from 53 to 117 mm, occupied by crabs of 40 to 112 mm carapace width. The depth of the burrow usually varied from 0.7 to 1.45 m and exceptionally up to 3.3 m.

Burrow pattern: Burrows are usually with a single external opening (94.17%), occasionally with two openings (5.0%) and rarely with three openings (0.83%). The tunnels often do not reach to the groundwater level. Dry burrows are quite common. The fresh deposition of excavated mud, usually on the creek-side, may be noticed on the sloping shore.

Burrow activity: Burrows are built by crabs of 40 mm across the carapace and above. The crabs are capable of forward and backward movement inside their burrows. They move sideways as a rule with the help of their walking legs. During daytime crabs are not normally seen to be active outside their burrows. Moulting of crabs inside the burrow has also been encountered during summer at *morani*, the lowest low tide periods from fifth to eighth day after full moon and new moon. The females are cannibalistic on the moulting males inside the burrow, while the males guard the moulting females, often embracing them with their legs.

Burrow temperature: The burrows provide an almost equitable temperature of 28 to 30°C measured at about 50 cm depth between 1000

TABLE 1

MORPHOMETRIC MEASUREMENTS OF *Scylla serrata* AND THEIR BURROWS FROM MATLA ESTUARY, CANNING

	Size and sex of crabs				Size of burrows		
Size group (mm)	Sex	Length	Width	Depth	Length	Width	Depth
40-49	4 females	27-31	41-47	17-18	61-72	39-52	500-710
	6 males	25-32	40-47	16-20	53-82	41-65	420-650
50-59	16 females	35-39	56-59	22-25	52-79	45-62	230-850
	8 males	33-39	51-58	21-26	58-76	44-49	370-800
60-69	24 females	38-44	61-68	22-27	55-79	40-59	370-800
	10 males	40-47	63-70	25-29	59-79	50-63	380-1400
70-79	10 females	44-48	70-74	27-28	69-82	65-75	480-750
	9 males	46-52	70-79	29-32	67-100	48-72	670-1450
80-89	10 females	53-57	80-85	35-36	76-82	60-74	400-1050
	9 males	53-58	80-88	31-35	68-76	63-70	550-1200
90-99	3 females	59-60	90-92	37-38	76-79	54-68	540-780
	1 male	54	90	37	70	65	720
100-109	–	–	–	–	–	–	–
110-119	1 male	69	112	8.5	117	88	3300

All measurements in mm.

and 1500 hrs even when the shore temperature was as high as 40°C.

Occurrence and distribution: During April and May 1986, a total of 120 burrows were selected at random from Matla estuary, Canning. They were excavated to trace the course of the burrow, measure the depth and diameter and to identify the male and female inhabitants. Of the 120 burrows excavated, 113 had a single opening, six had two and one had three openings on the surface. Out of 113 burrows with one opening, 38 were occupied by males, 60 by females, 3 by both male and female and 12 had no crabs. Of the six burrows with two openings, four were inhabited by females and two by males only. A burrow with three openings outside was occupied by a male crab of 112 mm size. Out of 120 burrows excavated, only 108 contained a total of 111 crabs. Of the 111 crabs, 44 were males and 67 were females.

TABLE 2

POPULATION DENSITY OF *Scylla serrata* FROM HOOGHLY AND MATLA ESTUARIES.

Place	Range (individuals/sq. m)	Mean
Hooghly estuary:		
Fatikpur	0.32–1.04	0.48
Pathar Pratima	0.44–1.28	0.60
Agunmarir Chara	0.36–1.12	0.52
Matla estuary :		
Nikarighata (Canning)	0.24–1.20	0.56

The crabs were of 40-112 mm carapace width. They are categorised according to size groups as follows: 10 crabs of 40-49 mm, 24 crabs of 50-59 mm, 34 crabs of 60-69 mm, 19 crabs each from 70-79 mm and 80-89 mm, and one crab of 110-119 mm. Out of 111 crabs, 106 were hard-shelled while five crabs were freshly moulted. Of the latter, three were females and two were males. Of these, one freshly moulted male crab (76 mm) was found to be partly eaten by a female crab of 81 mm, sharing the burrow of 70 x 60 mm with a depth of 840 mm.

The occurrence, distribution and morphometric measurements of the crabs and their burrows are shown in Table 1.

It is apparent from Table 1 that there is a correlation between the morphometric parameters of the crabs and their burrows. The longest diameter of the burrow is about 1.5 times the length of the crab inhabiting the burrow. The width of the burrow is nearly twice the depth (thickness) of the crab. These relation-

ships are particularly pronounced in the higher size groups.

Population density: The population density of *Scylla serrata* was estimated from four places as Hooghly and Matla estuaries, by hooking out crabs from their burrows with the help of professional crab-fishers. Six plots of 25 sq. m area from each place were selected from the mid-littoral to upper littoral zones from different places and studied. The maximum and minimum densities recorded are shown in Table 2. The population density ranges from 0.32 to 1.28/sq. m in the Hooghly estuary and from 0.24 to 1.20/sq. m in the Matla estuary.

Discussion

Members of the family Portunidae, of which *Scylla serrata* Forskal is the largest and commonest species, are essentially fast swimming marine crabs. Among swimming species, Portunidae is the only family in which this ability dominates the lifestyle (Hartnoll 1971). Our observations clearly indicate that *S. serrata* is admirably adapted to a burrowing habit.

There are two main types of burrowing crabs, namely back-burrowers and side-burrowers (Warner 1977). *S. serrata* appears to belong to the latter group, but this needs further study. They construct characteristically ellipsoidal burrows which serve as the shelter for at least a part of their life, perhaps to spend the days during moults. The longest diameter of the burrow corresponds to the length of the crab so that they can move in and out sideways easily as and when needed. However, from the morphometric data on crabs and burrows, it is seen that this diameter is not exactly comparable. Our experience suggests that this deviation is due to fishermen's activities since they frequently use hooks to pull the crabs out of their burrows, leading to distortion of the burrow.

The depth of the burrow in the upper littoral zone is considerably higher. This is due to dryness of the surface soil and higher moisture in the soil underneath. The distribution and zonation of the burrow is associated with the nature of the substratum and their tolerance to fluctuation in salinity of subsoil water, humidity, temperature, desiccation and water stresses of the intertidal environment. The bottom of the burrow, however, provides an equitable temperature of 28–30°C (Macintosh 1977).

The size and density of the crab population depend on its habitat (Macintosh 1984). However, the population density of *S. serrata* is higher in the slope side of the creek than in the mangrove forest. It indicates that the mangrove environment is the secondary habitat of this portunid species.

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References

Bakshi, S.K., Ray, T.K. & De, C. (1980): On the workings of some crabs on the sandy beach of Western Sundarbans, Bengal delta, India. *J. Geol. Soc. India 21(4):* 184-187.

Chakrabarti, A. (1971): Beach structures produced by crab pellets. *Sedimentology 18 :* 129-184.

Chakrabarti, A. (1980) : Influence of biogenic activity of ghost crabs on the size parameters of beach sediments. *Senckenb. Marit. 12 (5-6):* 183-199.

Chakrabarti, A. & Das, S. (1983) : Burrow pattern of *Macrophthalmus telescopicus* and their environmental significance. *Senckenb. Marit. 15(1-3):* 43-54.

Hartnoll, R.G. (1971) : The occurrence and significance of swimming in the Brachyura. *Anim. Behav. 19:* 34-50.

Macintosh, D.J. (1977): Some responses of tropical decapod crustaceans to life in mangrove swamps. *Mar. Res. Indonesia 18 :* 63-72.

Macintosh, D.J. (1984) : Ecology and productivity of Malaysian mangrove crab populations (Decapoda :

Brachyura). *Proc. As. Symp. Mangr. Env. Res. and Manag.* pp. 354-377.

MACNAE, W. (1968) : A general account of the fauna and flora of mangrove swamps and forests in the Indo-West Pacific region. *Adv. Mar. Biol. 6 :* 73-270.

SILAS, E.G. & SANKARANKUTTY, C. (1967) : Field investigations on the shore crabs of the Gulf of Mannar and Palk Bay with special reference to the ecology and behaviour of the pellet crab *Scopimera proxima.* Kemp. Proc. Symp. on Crustacea, Part III. Marine Biological Association of India, Mandapam. pp.1008-1025.

WARNER, G.F. (1977) : The Biology of crabs. Elek Science, London.

BIRDS OF THE KARERA BUSTARD SANCTUARY, MADHYA PRADESH[1]

Asad R. Rahmani[2]

(With two plates and two text-figures)

Birds seen in the Karera Bustard Sanctuary, Madhya Pradesh, during a 5 year study (1982-1986) are listed, along with a brief report on their status and interesting observations. Data is compared with observations made in similar and/or nearby areas by Salim Ali on a survey in 1938.

Introduction

In 1938 Salim Ali conducted ornithological surveys in the then princely states of Bhopal, Gwalior, Indore and Dhar. His field trips were from January to April and August to September. In 1939 he published his results in two parts (Ali 1939). He collected 886 specimens and noted 278 bird species in Central India, as parts of Madhya Pradesh were known at that time. He also mentioned the dates and places visited by him during his collection trips. Some of these areas like Narwar, Surwaya and Badarwas are close to Karera (Fig. 1) where we did field studies on the great Indian bustard (Rahmani 1988b). During this study between 1982 and 1986, a weekly census of avifauna of the area was done on a predetermined census path, and general notes on the birdlife of Karera Bustard Sanctuary were maintained. While results of the weekly bird census will be given elsewhere, this paper deals only with the birdlife of the Karera Bustard Sanctuary and its immediate environs.

I have compared my data with the birds noted by Ali (1939) from Gwalior and Shivpuri districts only and not from other areas like Dhar, Bhopal and Indore which he visited during his surveys. Moreover I have compared my data of Karera (open scrubland, see below) with ecologically similar areas like Narwar and Surwaya and not with the forested areas which Salim Ali visited during his work.

In Gwalior state, Salim Ali collected birds at the following places: Kuno, Narwar Fort, Surwaya, Badarwas, Guna, Chanderi, Bhind, Sardarpur and Bagh (see Ali 1939). As he had covered a larger and more varied area he noted more species (i.e. 278 v/s 258). However, as I spent a longer period in the field I was able to see many uncommon species which could be overlooked during a short visit. While Salim Ali has made his checklist on the basis of birds collected and/or seen, my checklist is limited to the birds seen and sometimes ringed (chiefly waterbirds were ringed) and therefore many skulking and difficult species (i.e. some warbler species) which can be positively identified only in the hand, are not included in my list.

Study Area

The 202.21 sq. km Karera Bustard Sanctuary (KBS) was established by the Madhya Pradesh state government in 1981. The sanctuary lies between 25°3' to 25°40' N and 78°5' to 78°12' E. Karera town is just 3 km away from the nearest point in the sanctuary, but the main bustard area is nearly 20 km further. Karera is a tehsil town, 45 km from Jhansi and 52 km from Shivpuri on Jhansi-Shivpuri road.

Most of the KBS is gently undulating, with scattered stones and boulders. There are a few chains of hillocks and the highest peak of the sanctuary is Kharicha hillock (368 m). A few decades ago these hillocks were covered with *Anogeissus pendula* trees, locally called *kardhi*. Indiscriminate cutting and lopping of these trees

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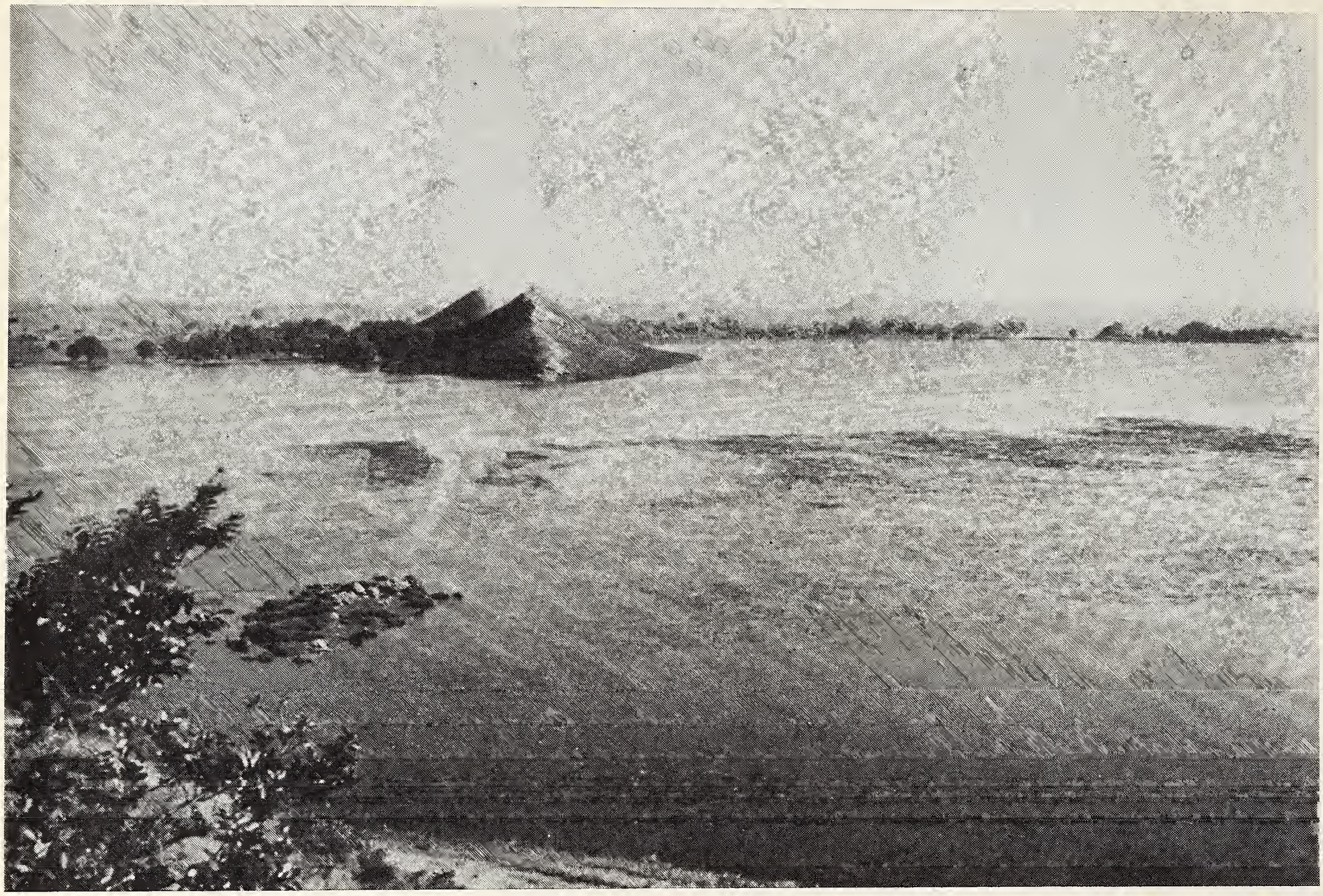
Above: Open scrubland in the Karera Bustard Sanctuary, the favourite habitat of the great Indian bustard.
Below: The natural vegetation of the Karera Bustard Sanctuary is dominated by clumps of *Zizyphus rotundifolia*.



Above: Dihaila jheel is an important wetland of Karera.
Below: Openbill storks breed regularly in Barsori-Fatehpur tank.

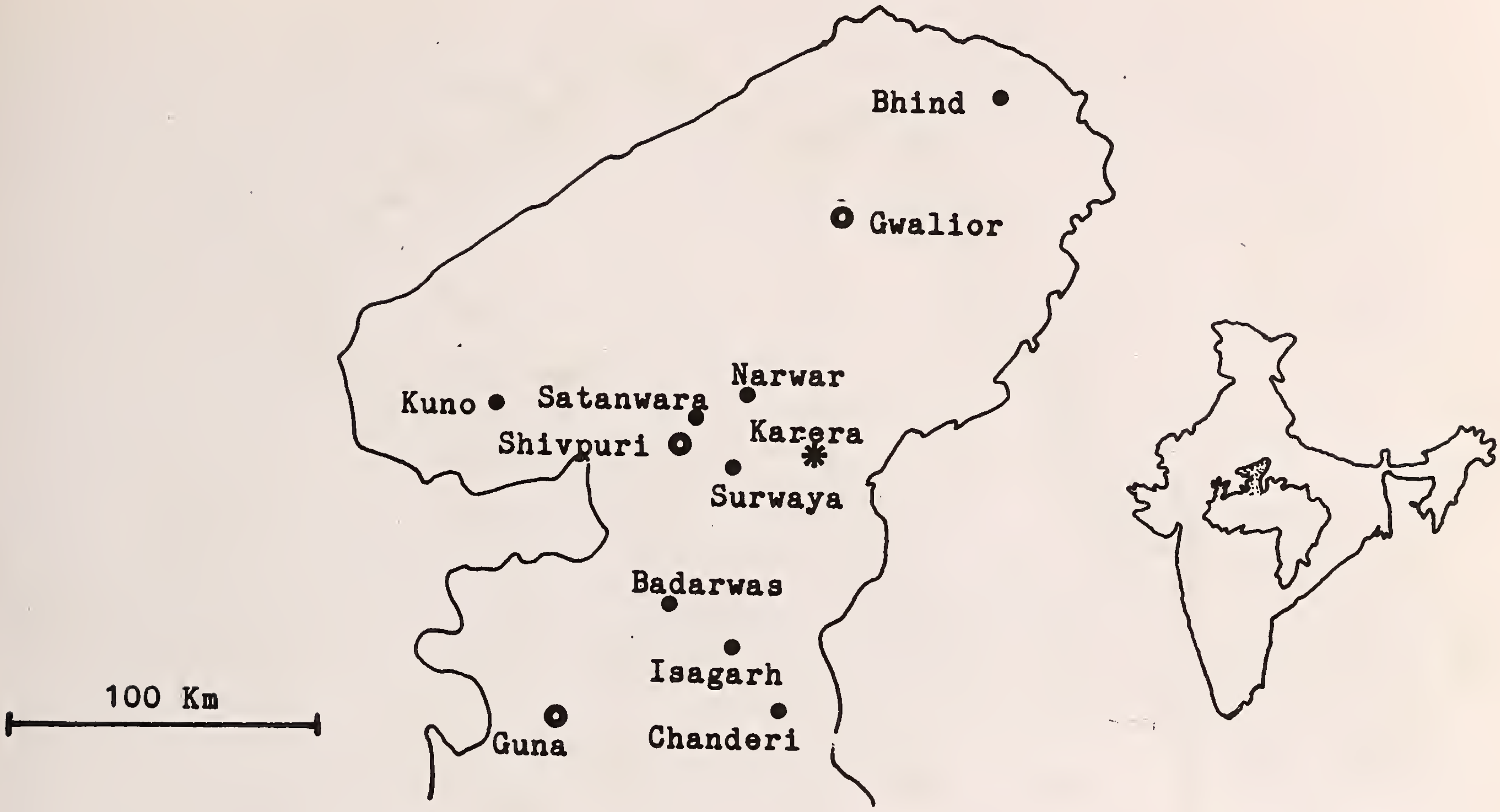


Fig. 1. Areas visited by Salim Ali in 1938. O=district headquarter, ●=other town, * =present study site.

has eroded the hillocks. Based on Champion and Seth's classification (1968), Karera area should come under Northern Tropical Dry Deciduous Forest (5 B - DS4). However, the natural vegetation has been much altered and now most of the uncultivated area is covered with *Zizyphus rotundifolia* and *Acacia leucophloea*. While the *Acacia* trees are scattered, *Zizyphus* can be seen in clumps.

Numerous seasonal streams criss-cross the sanctuary. They either end in percolation tanks or into the Sind and Mahuar rivers (Fig. 2). These streams stop running by the end of the monsoons but water remains in small pools for a few more months. In addition, there are many man-made waterbodies where water is collected during the monsoon for irrigation purposes. These waterbodies attract a large number of waterbirds. The following are the main waterbodies within the sanctuary:

1. Dihaila jheel: This is the largest wetland in the sanctuary. During good rainfall years its size may extend up to 370 ha. but generally it remains much smaller. Dihaila is in a natural depression but its water capacity is increased by the construction of two bunds near Rajpur and Dihaila villages (see Rahmani 1987, 1988a for more details).

2. Ronija: A small waterbody of 10-15 ha. near Ronija village. This semi-natural waterbody is drained for cultivation during September-October and migratory birds are attracted to its drying and muddy ground. It is an important foraging ground for spoonbills, storks, ibises, egrets and waders.

3. Barsori-Fatehpur tank: This tank lies between Fatehpur and Barsori villages. A long bund of about 250 m impounds rain water in about 30 to 40 ha. of land. There are some *Acacia* trees near the tank and when it gets flooded, these trees are surrounded by water, thus serving as a good nesting place for openbill storks, cormorants, darters and egrets.

4. Berkhera tank: This 104 ha. tank is more or less perennial, and attracts a very large number of ducks and geese. Owing to higher water

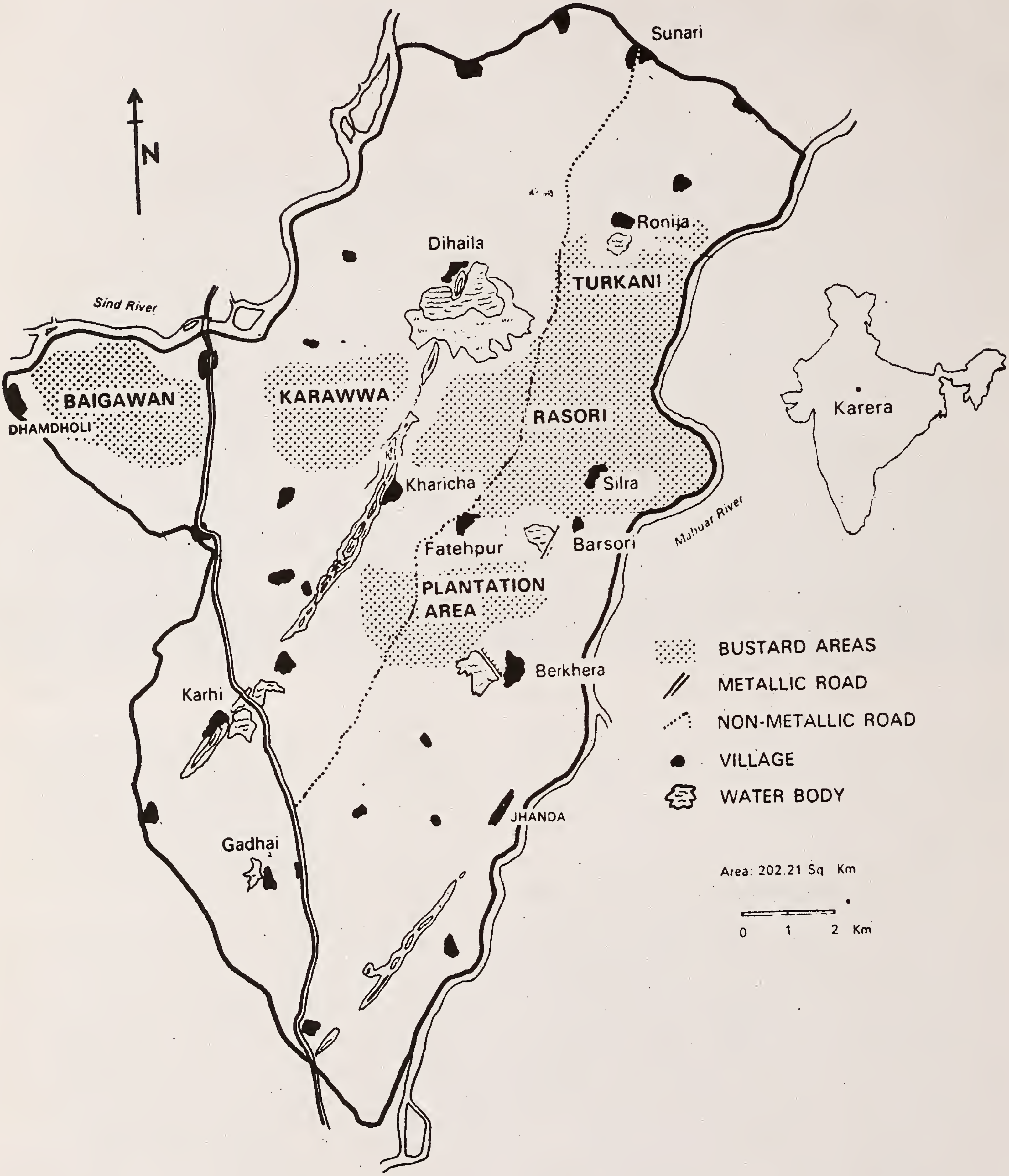


Fig. 2. Map of Karera Bustard Sanctuary.

depth (3-5 m) diving ducks are comparatively more common than the dabbling species.

5. Karhai-Ramgarha tanks: These two shallow tanks are separated by a metalled road. Very good for dabbling ducks and waders.

6. Gadhai tank: Another irrigation tank, good for waterfowl.

There are a few more waterbodies like Barawwa, Bansgarh and Andar outside the sanctuary, which we visited a few times. Owing to the presence of waterbodies and the two rivers, there is no scarcity of water for wildlife. The water table of the area is high and almost all the cultivators have wells for irrigation.

Human habitation: There are 33 villages inside the notified sanctuary area (Fig. 2) and the approximate human population residing inside the sanctuary area is 25,700 (1981 census), which comes to 127 per sq. km Livestock population is also very high, about 180 per sq. km. Out of the 202 sq. km nearly 145 sq. km is under agriculture and/or privately owned, and the remaining 55.5 sq. km is government land. Almost all the government land is used for livestock grazing. The privately owned land is not fully under the plough; some lies fallow or is used as private grazing land. There are a few sacred groves consisting of more or less pure stands of *Anogeissus pendula*.

The main crops of the area are (listed according to decreasing percentage cultivated): wheat, Bengal gram, maize, groundnut, pulses, paddy, sugarcane and vegetables.

Study Period

As reported earlier, this work was done at Karera while studying the ecology of the great Indian bustard from June 1982 to December 1986. A few visits were made during 1987 and 1988 also. Notes were maintained of all the unusual sight records, first and last sightings of migrants, unusual numbers seen, and display or nesting of resident birds. Most of the birds were recorded by me but a few were not seen by me but seen by my colleagues Eric D'Cunha and Bharat Bhushan are also included in the list.

Bird ringing under the Avifauna Project of the BNHS was started in 1984, during which 305 birds of 20 species were ringed. Large-scale ringing was done in 1985-86 and 1987-88.

Results

The Bird List of the Karera Bustard Sanctuary

Abbreviations used:
M = Migratory, LM = Local Migratory,
C = Common, U = Uncommon, O = Occasional,
R = Resident, * = ringed at Karera,
+ = not recorded by Salim Ali (1939).

1. **Great crested grebe**
Podiceps cristatus M, O, +
A few seen every year in the waterbodies of Karera. Two seen in Bansgarh tank on 11 December 1982, two in Barawwa tank on 15 January 1983 and two in Dihaila on 22 January 1983.

2. **Blacknecked grebe**
Podiceps nigricollis M, O, +
Recorded from Berkhera in January 1987.

3. **Little grebe**
Podiceps ruficollis R, C, *
Breeds in Dihaila and other waterbodies. Chicks seen every year during the monsoon. 196 adults seen in Karhai and Ramgarha tanks on 25 April 1986. Seen in association with pintail, gadwall, shoveller and coot for foraging. For example, on 12 January 1987, 44 grebes were seen in association with coots.

4. **Spottedbilled pelican**
Pelecanus philippensis M, O, +
One seen on 26 November 1982 and two in the winter of 1986-87.

5. **Large cormorant**
Phalacrocorax carbo LM, C
Common in large waterbodies like Dihaila and Berkhera.

6. **Indian shag**
Phalacrocorax fuscicollis LM, C, *, +
Along with little cormorant, seen in many waterbodies of the sanctuary. On 1 November 1982, 83 seen flying in the direction of Dihaila.

7. **Little cormorant**
Phalacrocorax niger R, C, *
Common in all the waterbodies. Breeds in mixed colonies in Barsori-Fatehpur tank. Chicks seen in September 1986.

8. **Darter** *Anhinga rufa* R, C
More commonly seen in Berkhera. One nest with two chicks found in Barsori-Fatehpur tank in September 1986.

9. **Grey heron** *Ardea cinerea* LM, C
Present in all the tanks in small numbers. Seen throughout the year but nesting not recorded.

10. **Purple heron** *Ardea purpurea* LM, U
Appears to be less common than the grey heron but found throughout the year. Nesting not recorded.

11. **Little green heron**
Ardeola striatus LM (?), O
A few sightings in Dihaila.

12. **Pond heron** *Ardeola grayii* LM, C
Very common in Dihaila and Karhi-Ramgarha. Breeding not recorded.

13. **Cattle egret** *Bubulcus ibis* LM, C
Very common with herds of livestock. Also seen after showers in small flocks in the scrub area. Breeding not recorded.

14. **Large egret** *Ardea alba* LM, C
Generally uncommon, but a few birds always seen in Berkhera and Dihaila. Large numbers (50-100) seen in December 1986 and January 1987 in the drying pools of Dihaila. Possibly one nest on a tree in Barsori-Fatehpur tank in 1986.

15. **Smaller egret** *Egretta intermedia* LM, C
More common than the large egret . Seen throughout the year. One or two nests on trees in Barsori-Fatehpur tank every year.

16. **Little egret** *Egretta garzetta* R, C
The commonest of the egrets. Breeds regularly in Fatehpur tank area.

17. **Indian reef heron** *Egretta gularis* M, O
One seen on 15 January 1983. Sighting of this species so far inland is unusual. The possibility of a grey morph of *E. garzetta* should not be overlooked.

18. **Night heron**
Nycticorax nycticorax LM, U, *, +
No breeding record. One ringed on 17 December 1985.

19. **Painted stork**
Mycteria leucocephala LM, C
Sometimes up to 400 seen in Dihaila. One nest in Barsori-Fatehpur tank area in September 1983.

20. **Openbill stork** *Anastomus oscitans* R, C
A few seen in Dihaila and Berkhera in winter months. Up to 30 nests on two *Acacia* trees in Barsori-Fatehpur tank area in 1986. Found nesting every year on the same trees. More common during monsoon, when it comes for breeding.

21. **Whitenecked stork**
Ciconia episcopus LM, U
Most records from the scrub area just after the rains. Even unseasonal showers in May-June will bring these birds to the scrub area where they forage for insects. No breeding record. However, Ali (1939) reported an active nest on 1 April 1938 on top of bare *Bombax malabaricum* on river bank at Ruthiai in Guna district.

22. **White stork** *Ciconia ciconia* M, O
One on 16 October and two on 26 November 1982. Ten in the winter of 1986-87. Ali (1939) saw 3 or 4 in a tank in Chanderi and wrote "the only meeting in Central India".

23. **Blacknecked stork**
Ephippiorhynchus asiaticus LM, O
A pair each on 29 November 1982 and February 1983, and a single bird each on 20 March 1984 and 26 May 1985. Again a pair with two juveniles in March 1986.

24. **Lesser adjutant**
Leptoptilos javanicus LM, O, +
One on 7-8 September 1985, another on 9 September 1986.

25. **White ibis** *Threskiornis aethiopica* R, C
Common in all the waterbodies. Breeds regularly in small numbers in Barsori-Fatehpur tank area. Four nests with fledged chicks in Sep-

tember 1986.

26. **Black ibis** *Pesudibis papillosa* LM, U
Frequently seen in the dried up parts of the waterbodies. No breeding record.

27. **Glossy ibis** *Plegadis falcinellus* LM, U
Sometimes seen in Dihaila. Uncommon in other tanks.

28. **Spoonbill** *Platalea leucorodia* R, C
Seen in Dihaila as long as the water lasts.

29. **Greater flamingo**
Phoenicopterus roseus LM, U, +
23 seen on 5 December 1982 and the same number on 22 January 1983. 40 in the winter of 1983-84 in Dihaila and 63 in 1985-86.

30. **Lesser flamingo**
Phoeniconaias minor LM, U, +
Only one seen with *P. roseus* in 1983-84.

31. **Greylag goose** *Anser anser* M, C, +
Up to 300 in Dihaila and Berkhera. Not seen in other waterbodies.

32. **Barheaded goose** *Anser indicus* M, C, *
500 to 600 in Dihaila and Berkhera. Do great damage to Bengal gram crop. In some years seen till the second week of April.

33. **Lesser whistling teal**
Dendrocygna javanica LM, C, *
Common in certain months. Up to 200 can be seen. No nesting record. Come with the rains but disappear in August-September, evidently for breeding elsewhere. Again seen in winter months in smaller numbers. Sometimes seen in early June in the rivers. Ali (1939) saw small flocks in Chanderi up to the end of April.

34. **Ruddy shelduck**
Tadorna ferruginea M, C, *
Arrives in October and leaves at the end of April. A few birds seen till early May. On arrival flocks of up to 70 birds seen in Dihaila but later in smaller parties or pairs.

35. **Pintail** *Anas acuta* M, C, *
One of the most common ducks. Arrives in September and leaves by end of March. Found in all the waterbodies.

36. **Common teal** *Anas crecca* M, C, *
Extremely common. Found in all the tanks of the sanctuary.

37. **Spotbill duck**
Anas poecilorhyncha R, C, *, +
Found throughout the year. Possibly breeds on the Sind river. One parent with three ducklings seen in a vegetation-filled pond, about 20 km from Dihaila in 1985.

38. **Mallard** *Anas platyrhynchos*, M, U
Three seen in January 1988 and two in November 1988.

39. **Gadwall** *Anas strepera* M, C, *, +
Common in all the waterbodies. Usually seen in pairs.

40. **Wigeon** *Anas penelope* M, C, *
Common in all the tanks.

41. **Garganey**
Anas querquedula M, C, *, +
Very common. Seen in all the tanks.

42. **Shoveller** *Anas clypeata* M, C, *
Very common. Seen till late April or even up to May.

43. **Redcrested pochard**
Netta rufina M, C, *, +
Seen mainly in Dihaila and Berkhera. Attempted copulation seen in February-March before the birds started going back.

44. **Common pochard** *Aythya ferina* M, C, *
Common, seen mainly in Berkhera and Dihaila.

45. **White-eyed pochard**
Aythya nyroca M, U, *
A few seen every year in mixed flocks of *A. ferina*. Ali (1939) saw it in Satanwara, about 60 km from Dihaila. Hewetson (1956) found it to be more common than the redcrested pochard but in Karera region the opposite is the case.

46. **Tufted duck** *Aythya fuligula* M, C, *
Common in Dihaila and Berkhera. Ali (1939) saw them in Satanwara.

47. **Scaup duck** *Aythya marila* M, U, *, +
A male caught and ringed on 23 November 1985. (Natarajan and Sugathan 1987).

48. **Cotton teal**
Nettapus coromandelianus R, C, *
Breeds in many waterbodies. Eight chicks

seen on 4 November 1982 in Dihaila and seven chicks seen on 16 October 1983 in a small waterbody near Fatehpur tank.

49. **Comb duck**
Sarkidiornis melanotos R, C, *

Common in Dihaila throughout the year depending upon the water level. A few hundred birds moult in the jheel during winter, during which period they become flightless. During moulting period wing flapping very common. Soon after the rains, flocks seen in the scrub area with males displaying, but nesting not recorded in KBS. Ali (1939) also found it to be fairly common, in flocks of up to 25. On 9 March 1984, a sick female was found in Dihaila, and caught the next day. Its crop was swollen and hard. It died by 11th morning. 604 Bengal gram seeds were found in the crop in a tight bunch; very few in the stomach. The intestine was empty. Some green vegetable matter – probably covering of gram pods – was found in the mouth and gullet. The bird was not injured and was otherwise normal. It probably died of hunger and exhaustion after the gram seeds got stuck in the crop.

50. **Blackwinged kite** *Elanus caeruleus* R, C

Breeds in the sanctuary. Seen almost throughout the year. Three juveniles with two parents seen on 27 May 1987.

51. **Honey buzzard**
Pernis ptilorhyncus R, U, +

52. **Pariah kite** *Milvus migrans* R, C

Common around villages and towns but rarely seen in the scrub area.

53. **Brahminy kite** *Haliastur indus* M, C

Occasionally seen near Dihaila. Ali (1939) did not see any in Gwalior region.

54. **Shikra** *Accipiter badius* R(?), U

Sparingly seen, mainly near groves of villages. Possibly breeds in or around the sanctuary. Ali (1939) collected one female from Narwar.

55. **White-eyed buzzard eagle**
Butastur teesa R, U

Mainly seen from March onwards, sometimes following great Indian bustard to catch the insects flushed by it (see Rahmani and Manakadan 1986 for more details). Uncommon in winter.

56. **Tawny eagle**
Aquila rapax vindhiana M, U, +

Two raptors with very dark plumage seen in the first week of July 1985 near Dihaila. Believed to be this species. Ali (1939) collected two specimens from Kuno and Narwar and found them to be common.

57. **Greater spotted eagle**
Aquila clanga M, U

First seen on 26 November 1982 on a rock near Dihaila jheel. A sickly bird seen on a hillock near Dihaila on 7 March 1986. It allowed approach within about one metre before flying off laboriously. Another normal bird also seen in the same area the same day.

58. **Pallas's fishing eagle**
Haliaeetus leucoryphus LM, U

Two immature birds seen trying to catch a coot on 7 January 1986 in Dihaila. Ali (1939) noted this species on the Chambal river near Gwalior-Dholpur border.

59. **Black or king vulture**
Sarcogyps calvus R, U

A nest found in March 1986 near Kharicha hillock. Both parents seen on the nest. Breeding was unsuccessful. This species has become uncommon and rarely seen although Ali (1939) found it to be common.

60. **Indian longbilled vulture**
Gyps indicus R, C

Very common vulture of the area. Nesting colonies present in Kharicha and Hajipur hillocks on cliffs. On 31 March 1988 on Kharicha hillock, prefledged chicks in some nests and a single egg being incubated in another nest.

61. **Indian whitebacked vulture**
Gyps bengalensis R, C

The most common vulture of the sanctuary. Large numbers seen around carcasses.

62. **Egyptian or scavenger vulture**
Neophron percnopterus R, C

Seen throughout the year. Possibly breeds in the area.

63. **Hen harrier** *Circus cyaneus* M, U, +

Uncommon winter visitor. One seen on 6

September 1985.

64. **Pale harrier** *Circus macrourus* M, U
Noted on a few occasions over five years.

65. **Montagu's harrier**
Circus pygargus M, C, +
The most common harrier in the sanctuary.

66. **Pied harrier**
Circus melanoleucos M, O, +
First noticed on 16 December 1982, later seen thrice in the winter of 1982-83 (Rahmani 1988b).

67. **Marsh harrier**
Circus aeruginosus M, C
Common in Berkhera and Dihaila. Sometimes seen in the scrub area also. Ali (1939) saw it in Satanwara and Badarwas.

68. **Short-toed eagle**
Circaetus gallicus R(?), U
Seen almost throughout the year in KBS. Possibly breeds in the sanctuary although nest not found. An immature seen on 29 June 1985, being mobbed by redwattled lapwings.

69. **Osprey** *Pandion haliaetus* M, U, +
One each seen on 1 February near Berkhera and on 20 December 1983 near Dihaila; two on 19 October 1985 near Dihaila.

70. **Bonelli's hawk-eagle**
Hieraaetus fasciatus R, U
A pair with a juvenile seen on Kharicha hillock on 10 June 1984 and again on 26 August 1984. One displaying by somersaulting, going up, closing wings and diving near the other bird. A nest found in Kharicha hillock in September 1984 and two adult birds seen. Subsequently the same nest was seen occupied in 1987 and 1988.

71. **Peregrine falcon**
Falco peregrinus peregrinator M, U
One seen on 21 October 1985 being chased by a marsh harrier.

72. **Lagger falcon**
Falco biarmicus jugger LM, U
One on 13 December 1982. Kept to the same area for a few days. Next sighted on 2 February 1983.

73. **Redheaded merlin**
Falco chicquera R(?), U
A pair seen on a neem (*Azadirachta indica*) tree on 4 November 1982 near Ronija fort. One seen on a telegraph pole on 13 July 1985. On 6 August 1983 three seen, two smaller (males?) and one larger (female?). The smaller ones were chasing and calling, while the larger individual was also flying nearby. Ali (1939) collected a pair from Badarwas on 28 March 1938. Stomach contents contained one leg each with feathers and remains of *Prinia sylvatica*.

74. **Kestrel** *Falco tinnunculus* M, U
Seen in the scrub area in winter. Ali (1939) collected two males from Narwar and Satanwara.

75. **Black francolin**
Francolinus francolinus R, C, +
Seen every year near Sind river and also near Turkani. Breeds during summer when males can be seen calling from a mound or a boulder.

76. **Grey francolin**
Francolinus pondicerianus R, C
Common around villages and fields. Breeds during summer, when the territorial call can be heard every morning and evening.

77. **Painted francolin**
Francolinus pictus R, C(?)
Seen a few times in the sanctuary. Call often confused with that of the black francolin. A pair seen in the evening on 11 July 1985. The male called once while the female kept on foraging. Later a pair seen near Turkani on 14 July 1985. Ali saw them in Kuno, Ruthiai, Chanderi and Isagarh.

78. **Common quail** *Coturnix coturnix* R, U
One seen on 11 July 1985 and a pair in another area later the same day. Ali (1939) collected a specimen on 25 February 1938 from Satanwara. He found them to be distinctly uncommon.

79. **Blackbreasted or rain quail**
Coturnix coromandelica LM, C, *
Fairly common during monsoon. Display

call sometimes heard from the first week of March but chiefly during June just before the monsoon breaks. Ali (1939) found them in the grassy country along the motor road from Gwalior to Shivpuri in August/September.

80. **Jungle bush quail**
Perdicula asiatica R, U
Easily confused with the rock bush quail. Found in many parts of the sanctuary. Once on 5 December 1982 a male tried to cover a female but was disturbed by another male. Ali (1939) collected many specimens from Kuno and Narwar.

81. **Rock bush quail**
Perdicula argoondah R, C
Fairly common in the scrub area and stony country. Ali (1939) collected seven specimens from Gwalior region and described a new subspecies, *meinertzhageni*.

82. **Common peafowl** *Pavo cristatus* R, U
Seen near some villages like Ronija but not in the scrub area. A nest with three eggs found in September 1984.

83. **Little bustard-quail**
Turnix sylvatica dussumier R, U, *
One seen on 29 June 1985 and a male with a chick near Turkani on 29 May 1986. One more bird seen on 2 June 1987.

84. **Yellowlegged button quail**
Turnix tanki R(?), U, +
One sight record.

85. **Common crane** *Grus grus* M, U, +
A few flocks seen or heard in flight every year in September/October.

86. **Sarus crane** *Grus antigone* R, C
Two or three pairs seen around Dihaila and one or two near Berkhera. Nesting seen every year. In 1982 four pairs with a chick each were noted in Berkhera, Dihaila and Ronija. In February 1986, a sarus was badly injured in a hailstorm (D'Cunha and Akhtar 1986). Sometimes seen in the scrub areas also, especially after the rains, foraging for insects. Roosting noted in the Sind and Mahuar rivers, the birds flying every evening towards the rivers. Ali (1983) also found this crane to be common.

87. **Siberian crane**
Grus leucogeranus M, U, +
One seen on 20 November 1988 in Dihaila. The first record from the state (Prakash and Hussain, in prep.).

88. **Demoiselle crane**
Anthropoides virgo M, U, *, +
Flocks seen flying every year in September/October. About 200 remained in the area in December 1984 for a few weeks. Again nearly 100 seen in December 1986 and January 1987. One ringed on 8 March 1988.

89. **Whitebreasted waterhen**
Amaurornis phoenicurus R, U
Breeds in small numbers in suitable localities. Nowhere common, possibly due to paucity of proper habitat. Ali (1939) did not note any during his survey of the Gwalior region.

90. **Moorhen** *Gallinula chloropus* R, C
Possibly breeds in some of the tanks like Berkhera. Common in all types of waterbodies. Noted during all the visits to Mahuar river.

91. **Coot** *Fulica atra* M, C, *
Abundant in winter in Dihaila, less so in other tanks.

92. **Purple moorhen**
Porphyrio porphyrio LM, C, *, +
Seen in small numbers in parts of Dihaila where emergent vegetation is thicker. Rarely seen in other waterbodies.

93. **Great Indian bustard**
Ardeotis nigriceps R, U, *
Between 25 and 30 bustards are present in the sanctuary. They are also seen in nearby areas like Narwar and Pohri (Ali and Rahmani 1982-84, Rahmani 1989). Ali (1939) noted it only in Esagarh but suspected its occurrence in other parts also.

94. **Lesser florican**
Sypheotides indica LM, U, +
First noted on 25 June 1982. Later seen in all years, especially during June when the birds were migrating towards their breeding grounds in north-west India.

95. **Pheasant-tailed jacana**
Hydrophasianus chirurgus R, C
Breeding noted only in Dihaila during 1985. Commonly seen in other waterbodies also, especially in Karhai-Ramgarha tanks. Ali (1939) also found it to be common.

96. **Bronzewinged jacana**
Metopidius indicus R, C
Three chicks in Dihaila on 16 October 1983. Present in all the waterbodies of the sanctuary.

97. **Painted snipe**
Rostratula benghalensis R, U, *
Possibly breeds in Dihaila. Both sexes seen throughout the year but nest not found. Ali (1939) collected a female on 27 February 1938 from Satanwara, and also saw the species in Chanderi.

98. **Blackwinged stilt**
Himantopus himantopus R, C, *
Breeds in Dihaila during summer depending on water conditions. Nest/chicks found in May 1983 and in June 1986.

99. **Stone curlew**
Burhinus oedicnemus R, U
Breeds in the scrub area. More often heard (at dusk) than seen. Not very common although Ali (1939) found it to be common. He collected a specimen from Badarwas, and noted it at Kuno and Surwaya. A chick seen in June 1984. On 21 October 1984 near Mahuar river two individuals were flushed from a spot which contained a large number of feathers and faeces. They must have been using the spot as a regular roost.

100. **Great stone plover**
Esacus magnirostris R, C
Common near rivers. Ali (1939) also noted it on Sind river near Narwar and Betwa river near Chanderi and also near Satanwara. Specimens were collected from Kuno and Badarwas.

101. **Indian courser**
Cursorius coromandelicus R, U
Breeds in the scrub area. Seen in small flocks of 8 to 10 birds. Chicks seen in May and June. Not common. Ali (1939) found it to be uncommon. He collected a male and a female from Satanwara on 25 February 1938, and noted it in Surwaya.

102. **Small Indian pratincole**
Glareola lactea LM, U, *, +
First recorded on 28 September 1982 in two flocks of 10 and 12 birds. They remained in the area till about 10 October. More seen in 1985-86 when Dihaila jheel was full.

103. **Whitetailed lapwing**
Vanellus leucurus M, C, *, +
Fairly common around Dihaila in the wet ground, less so in other waterbodies.

104. **Lapwing** *Vanellus vanellus* M, U
A dozen or so birds seen every year around Dihaila in the wet grounds.

105. **Greyheaded lapwing**
Vanellus cinereus M, U, +
First noted in December 1986.

106. **Redwattled lapwing**
Vanellus indicus R, C, *
Very common breeding bird. Ali (1939) also found it to be common.

107. **Spurwinged lapwing**
Vanellus spinosus R, C, *, +
Common near rivers. Eggs and chicks seen during May and June. Sometimes seen near Dihaila.

108. **Yellow-wattled lapwing**
Vanellus malabaricus R(?), U
Seen in scrub area. Possibly breeds in the sanctuary but nest not found. Ali (1939) found it to be not uncommon.

109. **Eastern golden plover**
Pluvialis dominica M, U, *, +
A few sightings from Dihaila in 1983 and 1985. Ringed in 1987-88.

110. **Grey plover**
Pluvialis squatarola M, U, *
Three ringed in the winter of 1985-86.

111. **Ringed plover**
Charadrius hiaticula M, U, *, +
One seen in 1983 and another banded in

1986. Supposedly a rare winter migrant to the country but possibly overlooked and not so uncommon.

112. **Little ringed plover**
Charadrius dubius M, C, *
Found in all the waterbodies but more so in Dihaila and Barsori- Fatehpur tanks. Some birds found in summer also but breeding not recorded from the area. Possibly belonging to resident race *C. d. jerdoni* which breeds within our limits.

113. **Kentish plover**
Charadrius alexandrinus M, C, *, +
Mixed flocks of Kentish and little ringed are common in Dihaila on the drying up pans, especially during March-April.

114. **Lesser sand plover**
Charadrius mongolus M, U, +
Frequently seen with other smaller plovers in Dihaila.

115. **Curlew** *Numenius arquata* M, U, *, +
Occasional sightings throughout winter but more common during March-April on return migration.

116. **Blacktailed godwit**
Limosa limosa M, C, *, +
Flocks arrive by mid September and stay till late April.

117. **Spotted or dusky redshank**
Tringa erythropus M, C, *
Seen in small numbers in all the waterbodies during winter.

118. **Redshank** *Tringa totanus* M, C, *
Seen in all the tanks during winter.

119. **Marsh sandpiper**
Tringa stagnatilis M, C, *
Very common in Dihaila. One seen eating a frog (Rahmani *et al.* 1990). Noted by Ali (1939) in Satanwara, Chanderi and Bhind.

120. **Greenshank**
Tringa nebularia M, C, *
Seen in all the waterbodies in small numbers in winter. One seen on 28 July 1983 with two secondaries of each wing moulting. Noted by Ali (1939) in Kuno, Satanwara, Narwar (Sind river), Surwaya, Chanderi and Bhind.

121. **Green sandpiper**
Tringa ochropus M, C, *
Very common in winter. Found in all types of waterbodies.

122. **Wood sandpiper**
Tringa glareola M, C, *
Very common in Dihaila and Karhai-Ramgarha tanks.

123. **Terek sandpiper** *Tringa terek* M, O, +
One seen on 20 October 1983 in Dihaila. Possibly a passage migrant as it is a maritime species.

124. **Common sandpiper**
Tringa hypoleucos M, C, *
Seen in all sorts of waterbodies.

125. **Fantail snipe** *Gallinago gallinago* M, C, *
Common in Dihaila but not in other waterbodies. Ali (1939) collected a female in Satanwara and saw the species in Surwaya and Chanderi.

126. **Jack snipe** *Gallinago minima* M, C, *
Birds usually not seen in the wild but many were trapped for ringing. Ali (1939) collected it at Satanwara.

127. **Little stint** *Calidris minutus* M, C, *, +
One of the commonest waders. Abundant in Dihaila. Enormous numbers seen in February-March.

128. **Temminck's stint**
Calidris temminckii M, C, *
Seen in mixed flocks with little stint in Dihaila. Ali (1939) collected two in Satanwara and saw them in Harsi lake near Gwalior.

129. **Dunlin** *Calidris alpinus* M, C, *, +
Common in Dihaila and Karhai tanks. 55 banded during 1984-86.

130. **Ruff and reeve**
Philomachus pugnax M, C, *, +
One of the most common waders in Dihaila, especially during September-October and February-March. Seen till late April, some males in partial breeding plumage. More than 1000 banded between 1984 and 1986.

131. **Brownheaded gull**
Larus brunnicephalus M, O, +
Two seen on 26 October 1985.

132. **Gullbilled tern**
Gelochelidon nilotica M, U
Some seen every year in Dihaila and Berkhera.

133. **Indian whiskered tern**
Chlidonias hybrida LM, C, *, +
Commonly seen in Dihaila and Berkhera. 15 banded between 1984 and 1988.

134. **Blackbellied tern**
Sterna acuticauda LM, C
A few seen every year in winter and also in summer.

135. **Indian river tern**
Sterna aurantia LM, C, *
A few seen every year near Dihaila and Berkhera.

136. **Indian sandgrouse**
Pterocles exustus R, C, *
In all, four nests were found, all of them in April. Seen throughout the year. Small flocks seen every day going to drink water from Mahuar river. Ali (1939) also found it to be not uncommon. He collected a male on 14 February 1938 from Kuno and saw them in Ummaidgarh Falls (Parvati river), Satanwara and Surwaya.

137. **Painted sandgrouse**
Pterocles indicus indicus LM, U
Uncommon in KBS because it prefers better forested areas (Ali and Ripley 1968-74). However, occasionally seen. One seen in flight on 9 September 1985. A pair in flight on 2 May 1987. Ali (1939) collected five specimens from Gwalior area and noted it near Narwar.

138. **Blue rock pigeon** *Columba livia* R, C
Common around villages and towns. Sometimes flocks seen feeding in fallow fields.

139. **Ring dove** *Streptopelia decaocto* R, C
Very common, seen everywhere. Nest found in *Acacia leucophloea* trees mainly during summer.

140. **Red turtle dove**
Streptopelia tranquebarica R, C
Pairs seen around villages and groves. Nest found on a mahua *Madhuca indica* tree at the height of 10 m, on 25 April 1986. According to Ali (1939) the least common among the doves in this area.

141. **Spotted dove**
Streptopelia chinensis R, U
Uncommon in the sanctuary but very common in the lightly wooded areas near Karera town, Surwaya and reserve forests.

142. **Little brown dove**
Streptopelia senegalensis R, C, *
Common everywhere, more so around villages and groves.

143. **Roseringed parakeet**
Psittacula krameri R, C
Large flocks seen every morning flying to the foraging areas. Common around villages and groves. Nest mainly seen in old neem trees.

144. **Blossomheaded parakeet**
Psittacula cyanocephala R(?), U
Uncommon in the sanctuary but common in the nearby reserve forests and better vegetated areas.

145. **Alexandrine parakeet**
Psittacula eupatria R(?), U
Uncommon in the sanctuary.

146. **Pied crested cuckoo**
Clamator jacobinus M, C
Seen with the arrival of monsoon in late June or early July and sometimes till the end of the year. Sometimes comes as early as end May: once heard in the night of 31 May and later seen/ heard five or six times in June. Commonly parasitises jungle and common babblers. One fledgling seen on 30 October 1982 being fed by common babblers.

147. **Brainfever bird** *Cuculus varius* LM, C
Calls become increasingly frequent from early March. In 1986 first call heard on 10 March at 0600 hrs. Possibly remains in the area throughout the year but overlooked when silent. In May and June it is commonly noticed flying from one grove to another, sometimes calling on the wing.

148. **Cuckoo** *Cuculus canorus* LM, U, +
Occasionally heard in summer. Not noted by Ali (1939) in the Gwalior area but he collected one specimen from Dhar.

149. **Koel** *Eudynamys scolopacea* R, C
Possibly the commonest of the cuckoos. Commonly heard during the monsoon period around villages and towns where it parasitises crows.

150. **Sirkeer cuckoo**
Taccocua leschenaultii R, C(?)
Sometimes seen in the scrub area. On 1 April 1988 two seen together, moving from tree to tree and flicking their tails. Ali (1939) also found it to be common in dry stony grass-and-thorn jungle.

151. **Crow-pheasant**
Centropus sinensis R, U
Uncommon in the open scrub area but common in the surrounding forests. Ali (1939) collected a male from Satanwara and saw it in Kuno, Surwaya, Narwar Fort and Guna.

152. **Great horned owl**
Bubo bubo R(?), U, +
Infrequently seen. Nest not found.

153. **Spotted owlet** *Athene brama* R, C, *
Common around villages, in old wells and dwellings even in the open scrub area.

154. **Shorteared owl** *Asio flammeus* M, O, +
Once seen in the tall grass area on 12 October 1982. Ali (1939) did not find it in the Gwalior region.

155. **Indian jungle nightjar**
Caprimulgus indicus R, U, +
Call heard on 11 and 18 April 1986.

156. **Franklin's nightjar**
Caprimulgus affinis R, U
A nest with two eggs on 10 June 1982. Heard many times in May-June 1983-84. Ali (1939) collected specimens in Satanwara and Narwar fort and found it to be common.

157. **European nightjar**
Caprimulgus europaeus O, *, +
One ringed and released on 12 November 1985 (Natarajan 1991, see pg. 284)

158. **Alpine swift** *Apus melba* M, U
Flocks seen in September-October 1983, and later in 1985. Ali (1939) found them in Satanwara.

159. **House swift** *Apus affinis* R, C
Seen throughout the year. Ali (1939) collected specimens from Narwar Fort and saw them at Satanwara and Chanderi.

160. **Pied kingfisher** *Ceryle rudis* R(?), C
Seen throughout the year. Possibly breeds near the rivers though nest not found.

161. **Storkbilled kingfisher**
Pelargopsis capensis R(?), U
Often seen in Mahuar river in the wooded parts.

162. **Whitebreasted kingfisher**
Halcyon smyrnensis R, C, *
Fairly common in Dihaila and Berkhera. Breeds near rivers. One nest located.

163. **Common kingfisher**
Alcedo atthis R(?), C
Seen throughout the year. Possibly breeds near the rivers and tanks though nest not found.

164 **Bluecheeked bee-eater**
Merops superciliosus LM, C, *
Erratic movement. Sometimes seen in large rambling flocks, together with bluetailed, in September and October. Less common or totally absent in other months.

165. **Bluetailed bee-eater**
Merops philippinus LM, C, *, +
Same as the preceding species.

166. **Green bee-eater**
Merops orientalis LM(?), C, *
Common everywhere but more seen in certain months when birds from other areas immigrate(?). Huge, more or less pure flocks seen at the end of September 1985. Comparatively few birds remained after a fortnight. Breeds during summer in small loose colonies on the sandbanks near Mahuar and Sind rivers. Ali (1939) also found a small colony on 25 March busy digging nest-tunnels in earth banks of Sind river.

167. **European** or **Kashmir roller**

Coracias garrulus M, U, +

Uncommon winter visitor but seen every year in small numbers during August-September when it is migrating further south. The earliest record is on 5 July in 1985. Rarely seen in other winter months. Not seen in spring when the birds return to their breeding quarters, apparently taking a different route.

168. **Indian roller**

Coracias benghalensis R, C, *

Regularly breeds in the sanctuary during summer. Four chicks on 22 April 1986. On 5 December 1982 a roller with half of upper mandible broken was seen. This species is frequently seen following the great Indian bustard to catch flushed insects (see Rahmani and Manakadan 1986).

169. **Hoopoe** *Upupa epops* R, C

Two races, *Upupa epops epops* (European hoopoe) and *U. e. ceylonensis* (Ceylon hoopoe) are seen in the sanctuary. Ali (1939) also found these two races in this area.

170. **Grey hornbill** *Tockus birostris* LM, U

Uncommon in the sanctuary as it prefers well wooded areas. Mainly seen near groves but sometimes in the open scrub, on the ground, feeding on insects. On 25 June 1982 a hornbill was seen following an Indian roller. It went after the roller from bush to bush, once settled on the ground and picked up something, then followed the roller again. This went on for more than five minutes. Ali (1939) noted this species in Surwaya and Satanwara.

171. **Green barbet**

Magalaima zeylanica R, U

Occasionally heard near some of the villages during summer months.

172. **Wryneck** *Jynx torquilla* M, U, *

Seen a few times in the scrub area. Once seen feeding on the ground on ants. One bird banded on 19 October 1985. Ali (1939) collected two females in February from Kuno and one male in March from Badarwas.

173. **Goldenbacked woodpecker**

Dinopium benghalensis R(?), U

Uncommon in the sanctuary but common in the forested areas. Ali (1939) collected specimens from Kuno and Chanderi and noted it in Gwalior fort and Surwaya.

174. **Mahratta woodpecker**

Picoides mahrattensis R(?), U

Uncommon. One seen on 1 November 1982, and then a female on 20 June 1985. A pair seen on 19 October 1985. Ali (1939) noted it in Satanwara, Narwar, Surwaya and Bhind and collected specimens in Kuno and Bagh.

175. **Redwinged bush-lark**

Mirafra erythroptera R, C, *

Very common. Breeds during summer and early rains. In 1986 first display seen on 9 March.

176. **Ashycrowned finch-lark**

Eremopterix grisea R, C, *

Frequently found feeding on the dusty cart-tracks and fallow land. Breeding commences from early summer when displaying birds are most often seen. According to Ali and Ripley (1968-74) breeding season irregular, continues more or less throughout the year. Once display seen at 0610 hrs on 8 October 1982.

177. **Rufoustailed finch-lark**

Ammomanes phoenicurus R, C

More commonly seen during summer when they breed.

178. **Short-toed lark**

Calandrella cinerea M, C, *

Enormous flocks seen from October onwards till the end of March.

179. **Sykes's crested lark**

Galerida deva R, C, *

13 ringed in 1985-86. Some specimens collected by Ali (1939) in the area.

180. **Eastern calandra lark**

Melanocorypha bimaculata M, U, +

Huge flocks seen on 22 January 1983. The birds remained in the area for about three weeks. Not seen in other years. Ali and Ripley (1968-74) have not reported this species from Madhya Pradesh.

181. **Crested lark** *Galerida cristata* R, C, +

Commonly breeds in the sanctuary.

182. **Eastern skylark**
Alauda gulgula R, C, *
Display seen from March onwards and nest found in April to June, sometimes later.

183. **Dusky crag martin**
Hirundo concolor R, C
Flocks seen in Kharicha hillock on 1 April 1988.

184. **Collared sand martin**
Riparia riparia M, U, +
A flock seen on 18 November 1985. Ali and Ripley (1968-74) have drawn attention to the superficial similarity of the two sand martins, *Riparia riparia* and *R. paludicola,* which share the same distribution in many areas and look similar in the field.

185. **Plain sand martin**
Riparia paludicola U, *
One ringed on 10 January 1988.

186. **Swallow** *Hirundo rustica* M, C
Common in winter all over the sanctuary but specially near Dihaila jheel where it hawks midges and gnats as they emerge from water. Vast numbers roost in the reed beds in Dihaila where the birds can be picked up on a dark night by shining a torch.

187. **Wiretailed swallow**
Hirundo smithii R(?), C
Possibly breeds in the area but nests not found. Common near Dihaila and Berkhera.

188. **Redrumped swallow**
Hirundo daurica M, C
Common in winter. Ali (1939) collected specimens from Kuno, Narwar fort and Chanderi and found old nests at Narwar.

189. **Great grey shrike** *Lanius excubitor* R, C, *
The commonest shrike in KBS, found everywhere in the scrubland. Most nests located in *Acacia leucophloea.* A nest with three eggs on 9 April 1983. On 5 June 1987 seen building nest on a telegraph pole. On 10 December 1982 a saw-scaled viper *Echis carinatus* was found in its larder (Rahmani and Bhushan 1985). On 24 December 1984 at 0930 hrs, one seen holding a struggling bird which appeared to be a lark.

190. **Baybacked shrike** *Lanius vittatus* R, U, *
Less common than the earlier species. More frequently seen around villages than in dry scrubland.

191. **Rufousbacked shrike**
Lanius schach R, C
Seen singly or in dispersed pairs, usually perched on a tree looking out for prey.

192. **Brown shrike** *Lanius cristatus* M, U, +
Occasionally seen in winter in the scrub area. According to Ali and Ripley's (1968-74) description of the distribution of this species (Vol. 5, p. 98), Karera falls slightly north-west of its range. Therefore, its sighting in Karera is a range extension.

193. **Golden oriole** *Oriolus oriolus* R, U
Usually seen in village groves. Fairly common around Karera town because there are many trees. Not seen in the dry, open scrub area.

194. **Black drongo** *Dicrurus adsimilis* R, C
A common bird of the scrubland. Sometimes seen following the great Indian bustard for insects but never seen perching on the bustard in Karera (Rahmani and Manakadan 1986). On 10 January 1988 it was found eating a bird which appeared to be a martin (D'Silva *et al.* 1990).

195. **Brahminy myna**
Sturnus pagodarum R, U, *
Not common in the scrub area but fairly common around towns.

196. **Rosy pastor** *Sturnus roseus* M, O
Occasional flocks seen in winter.

197. **Pied myna** *Sturnus contra* R, C ,*
Rarely seen in the scrub area and not uncommon around villages, where seen feeding on rubbish or other similar matter.

198. **Starling** *Sturnus vulgaris* M, C
Common winter visitor.

199. **Common myna** *Acridotheres tristis* R, C
Fairly common around villages, newly irrigated damp fields and human settlements. Breeds in old wells.

200. **Bank myna**
Acridotheres ginginianus R, C, *
Abundant. Breeds in old wells. Small

flocks or family parties forage in the scrub area.

201. **Indian tree pie**
Dendrocitta vagabunda R, U
Not seen in the open scrub area but frequently seen in the villages, groves and in the surrounding reserve forests.

202. **House crow** *Corvus splendens* R, C
Common resident.

203. **Jungle crow**
Corvus macrorhynchos R, C
Seen every morning flying over the scrubland going for foraging, evening flight in the reverse direction. Also seen foraging in the scrub area, especially on the damp soil and fallow fields. A major danger to bustard eggs. Egg predation observed when the bustard hen had gone to drink water.

204. **Common woodshrike**
Tephrodornis pondicerianus R, U
Uncommon but seen every year. Ali (1939) has noted it in Badarwas, Satanwara, Surwaya and Shivpuri.

205. **Blackheaded cuckoo-shrike**
Coracina melanoptera R(?), U, +
A female seen on 2 July 1985 in the scrub area. Not noted by Ali (1939) in Gwalior region surveyed between February and May.

206. **Whitebellied minivet**
Pericrocotus erythropygius R(?), U
A pair seen for the first time in December 1984 in Baigawan by Eric D'Cunha. Later sighting in 1985 was also in Baigawan. Ali (1939) collected specimens from Kuno, Magroni and Amjhera and noticed them in Narwar, Satanwara, Surwaya and Shivpuri.

207. **Redvented bulbul**
Pycnonotus cafer R, C, *
Common around villages, groves and shrubs.

208. **Yelloweyed babbler**
Chrysomma sinensis R, C, *
Fairly common around villages, fields, hedges and streams. Nest found on a young *Zizyphus* on 3 October 1983 with six blind chicks out of which only four fledged on 10th.

209. **Common babbler**
Turdoides caudatus R, C, *
The most common babbler in the scrubland. Found all over the sanctuary. Most nests seen during the monsoons but two fledglings seen on 27 April 1983. Nest generally located in *Acacia leucophloea* and *Carissa caranda* bushes.

210. **Large grey babbler**
Turdoides malcolmi R, C, *
Very common in the scrub area. Breeding seen during summer and monsoon months. In a nest monitored in October 1982, the chicks hatched around the 10th and fledged on 24th. Another nest with one unhatched egg and two 4-5 day old chicks was found on 26 November 1982. They fledged on 12 December. The chicks were fed cooperatively – sometimes four adult birds lining up to feed the chicks. The faecal sac was eaten by the adult even when the chicks were almost fledged. Most nests present in *Acacia leucophloea* trees deep inside branches and effectively protected by formidable thorns.

211. **Jungle babbler** *Turdoides striatus* R, U
Uncommon in the open scrubland but very common in the nearby forested areas.

212. **Paradise flycatcher**
Terpsiphone paradisi R, U
Nest found in May 1983 near Mahuar river on overhanging branches. Otherwise rarely seen in the sanctuary.

213. **Redbreasted flycatcher**
Muscicapa parva M, C, *
Common winter migrant. Found in groves and lightly wooded country in the sanctuary and not in the scrubland. Very common in the Madhav National Park near Shivpuri. Ali (1939) collected it near Kuno, Narwar fort and Surwaya.

214. **Whitebrowed fantail flycatcher**
Rhipidura aureola R, U
A nest on a *Ficus* tree with one egg on 1 April 1988. Not common in the scrubland but common in the groves and forested areas outside the sanctuary. Frequently seen in the Madhav N.P. in attendance on chital *Axis axis*, nilgai

Boselaphus tragocamelus and sambar *Cervus unicolor.*

215. **Streaked fantail warbler**
Cisticola juncidis R, C

Commonly seen from late summer in the scrubland and by early June can be seen displaying. Breeds with the onset of monsoon when the grass comes up. Nest found in grass-covered *Zizyphus* clumps so characteristic of the scrubland of Karera.

216. **Plain wren-warbler**
Prinia subflava R, C, *

Found in all the suitable localities in the sanctuary. More widespread after the rains when new vegetation comes up. Nest with three chicks found on 5 October 1982 in a grass-covered clump of *Zizyphus.* Another nest seen on 6 October with six chicks. Ali (1939) also found it to be common among *Zizyphus* and other thorn thickets mixed with tall grass, and also in patches of tall grassland. He collected specimens from Kuno, Badarwas, Satanwara and Bhind. In winter commonly seen in wheat and sugarcane fields.

217. **Rufousfronted wren-warbler**
Prinia buchanani R, C

The commonest wren-warbler in the scrubland. Found in dry areas where other warblers like *subflava* and *socialis* are generally not seen (except in monsoon). Display seen from March onwards and one nest with two eggs on 19 April. Most nests found were in *Zizyphus* clumps. Ali (1939) collected or recorded it in Satanwara, Kuno, Gwalior fort environs, Narwar fort, Badarwas and Bhind. According to Ali and Ripley (1968-74) it breeds mainly during the monsoon but earlier in the western parts of its range, i.e. Gujarat, Rajasthan and Pakistan, where nesting has been recorded from March to August. According to my observations in north-western Madhya Pradesh, it starts breeding from March.

218. **Ashy wren-warbler**
Prinia socialis R, C

Common in the sanctuary but generally found around villages in shrubs and crop fields like sugarcane and mustard. Not seen in dry scrub. More widespread after the rains with the growth of new vegetation and crops.

219. **Tailor bird** *Orthotomus sutorius* R, C

Not common in the scrubland. Mainly seen in shrubbery, along streams and in groves near villages. Ali (1939) collected it from Kuno, Narwar Fort and Badarwas, and noted it in Gwalior fort and Satanwara. On 10 June 1984 one individual observed to enter a cave in Kharicha hillock, possibly to drink water (there was some water in the cave).

220. **Great reed warbler**
Acrocephalus stentoreus M, U

Seen but more often heard in Dihaila environs in the reed beds and bullrushes. Not seen (although heard) in other waterbodies mainly due to paucity of reeds. Ali (1939) noted it only at Rampura tank near Guna.

221. **Orphean warbler**
Sylvia hortensis M, U

Infrequently seen in the better vegetated parts of Baigawan and around villages in shrubbery. Uncommon in open scrubland. Not seen by Ali (1939) in the Karera region.

222. **Lesser whitethroat**
Sylvia curruca M, C, *

Common winter migrant. Found in all types of habitats from scrubland, shrubbery to grove and forested facies. Ali (1939) collected specimens or noted it in Satanwara, Narwar fort, Surwaya, Kuno and Badarwas areas.

223. **Chiff-chaff**
Phylloscopus collybita M, C, *

The only *Phylloscopus* which I could identify with certainty. Ali (1939) collected specimens from Satanwara and Surwaya.

224. **Blue-throat** *Erithacus svecicus* M, C, *

Not seen in the open scrubland but frequently found in damp ground beneath shrubbery, irrigation channels near sugarcane fields and around vegetated streams. Ali (1939) collected it from Satanwara, Surwaya and Kuno.

225. **Magpie-robin** *Copsychus saularis* R, C

Common resident bird but not found in dry

open scrubland. Mainly seen around villages, streams and groves. Breeding noticed during summer. Young birds seen in August-September.

226. **Black redstart**
Phoenicurus ochruros M, C, *
Common winter migrant, seen in village groves and gardens. Not seen in open scrubland.

227. **Collared bush chat**
Saxicloa torquata M, C, *
Not uncommon in open scrubland. Birds generally seen sitting on top of small bushes, scanning the surroundings. Ali (1939) collected specimens from Satanwara and Narwar Fort and recorded it in Kuno and Badarwas.

228. **Pied bush chat** *Saxicola caprata* R, C, *
Seen throughout the year but more commonly in winter when migrants augment the local population.

229. **Dark grey bush chat**
Saxicola ferrea M, O, +
A female seen on 29 December 1985 near Fatehpur by D'Cunha. According to Ali and Ripley's (1968-74) description of its winter distribution, Karera is very much south of its normal range.

230. **Isabelline chat**
Oenanthe isabellina M, U, +
Mainly seen in the scrub forest and around fallow fields.

231. **Desert wheatear**
Oenanthe deserti M, C
The most common wheatear of the sanctuary. Found in winter all over the scrubland. Ali (1939) also found it to be common and collected five specimens from Satanwara.

232. **Pied wheatear** *Oenanthe picata* M, C
Common. The morph *O. picata picata* is seen in Karera. Ali (1939) found it to be excessively shy but I did not find it any different in behaviour from the other two wheatears. He collected four specimens from Satanwara and Surwaya areas.

233. **Brown rock chat** *Cercomela fusca* R, U
Seen only around Ronija fort and sometimes on boulders. Nest not found but possibly breeds in the area. Ali (1939) collected one male specimen from Gwalior fort, and saw nest building on 13 March.

234. **Indian robin** *Saxicoloides fulicata* R, C, *
Very common. Found all over the sanctuary, around villages, old dilapidated huts scattered in the sanctuary, boulders and ravine areas near rivers. Breeds during summer. Nest found in May and June.

235. **Blue rock thrush**
Monticola solitarius M, C
Frequently seen on boulders near Dihaila and in Ronija Fort. In 1984 a male seen till 17 April. Ali (1939) noticed it in Satanwara, Narwar Fort, Surwaya, Rampura tank and Gwalior Fort.

236. **Tree pipit** *Anthus trivialis* M, U
A small flock seen on 30 January 1986 by D' Cunha. KBS does not have many suitable habitats for this forest-loving species. It is not uncommon in the nearby reserve forests and in Madhav N.P. Ali (1939) collected it in Badarwas, Surwaya and Guna.

237. **Brown rock pipit** *Anthus similis* M, U, *
One bird seen by D'Cunha on 14 November 1985 and one ringed on 12 January 1988. Ali (1939) collected it in Kuno, Surwaya and Badarwas.

238. **Tawny pipit** *Anthus campestris* M, C
Very common in fallow fields, scrubland and pastures. Mainly seen from September to March. Ali (1939) collected specimens from Kuno, Badarwas, Satanwara and Surwaya.

239. **Paddyfield pipit**
Anthus novaeseelandiae C(?), *
Six ringed in 1985-86. Not easy to identify in the field.

240. **Blyth's pipit** *Anthus godlewskii* C(?), *
One ringed in the winter of 1985-86.

241. **White wagtail** *Motacilla alba* M, C, *
Common around Dihaila and all other waterbodies.

242. **Grey wagtail** *Motacilla cinerea* M, C, *
Common around Dihaila and all other

waterbodies.

243. **Yellow wagtail** *Motacilla flava* M, C, *
Common on wet ground, drying up jheels and recently watered stubble fields.

244. **Yellowheaded wagtail**
Motacilla citreola M, C, *
Common on wet ground, drying up jheels and recently watered stubble fields.

245. **Large pied wagtail**
Motacilla maderaspatensis R, C
The only resident wagtail. Nests located near Dihaila jheel and small, vegetation-covered islets in Mahuar river. Breeding recorded during summer.

246. **Purple sunbird**
Nectarinia asiatica R, C, *
Not generally seen in the scrubland but fairly common in shrubbery, gardens and groves. One nest on *Prosopis juliflora* with three eggs on 17 April 1986, chicks seen on 26th. Ali (1939) found nest with two chicks on 31 March, and juveniles out of the nest on 19 April. He also collected specimens from Satanwara, Badarwas and Surwaya.

247. **White-eye** *Zosterops palpebrosa* R, U
This forest bird is uncommon in the sanctuary. Ali (1939) collected specimens or noticed it in Narwar fort, Badarwas, Satanwara, Gwalior fort and Shivpuri.

248. **House sparrow** *Passer domesticus* R, C, *
Abundant. More seen during winter when birds from temperate region augment the resident population.

249. **Spanish sparrow**
Passer hispaniolensis M, C, *, +
Enormous flocks, mixed with house sparrow seen in winter around cultivation. Not common in the dry, open scrubland. According to Ali and Ripley (1968-74) the southern-most record of the Spanish sparrow is Bharatpur. Therefore, Karera is a range extension.

250. **Yellowthroated sparrow**
Petronia xanthocollis R, C, *
Common around human habitation. Nest seen during summer.

251. **Baya** *Ploceus philippinus* R, C, *
Nest found during monsoon on trees hanging in old wells, near streams and palm trees.

252. **Blackthroated weaver bird**
Ploceus benghalensis R, U, *
Less common than the baya.

253. **Whitethroated munia**
Lonchura malabarica R, C, *
Common in the scrubland, cultivated fields and around villages. Ali (1939) collected it from Kuno, Satanwara and Narwar, and saw it in Magroni, Harsi dam and Bhind.

254. **Spotted munia**
Lonchura punctulata R, U, *
Saw a nest on 27 August 1984 on *Acacia leucophloea*.

255. **Common rosefinch**
Carpodacus erythrinus M, U
A few flocks seen every year for short periods, for instance 15 seen on 30 January 1984. Ali (1939) collected it from Surwaya and noticed it at Chanderi and Badarwas.

256. **Blackheaded bunting**
Emberiza melanocephala M, U
Uncommon. Seen in mustard fields with redheaded buntings. Ali (1939) saw it in Satanwara and collected a male on 15 September from Amjhera.

257. **Redheaded bunting**
Emberiza bruniceps M, U, *
Not common in Karera area. Ali (1939) found it to be more common than the blackheaded bunting. He collected four specimens in March from Surwaya.

258. **Crested bunting**
Melophus lathami LM, U, *
Seen every year near Fatehpur village in mid-June for few days, apparently on local movement. Very common in Madhav N.P. Ali (1939) collected or saw it in Surwaya, Narwar fort, Kuno and Satanwara.

Discussion

Although Madhya Pradesh is centrally located in India and still has vast forest resources

TABLE 1

BIRDS NOT RECORDED EARLIER FROM MADHYA PRADESH BY MOSS-KING (1911), WHITEHEAD (1911), OSMASTON (1921), BRIGGS (1931), D'ABREAU (1931), ALI (1939), HEWETSON (1939, 1956) OR NEWTON *ET AL.* (1986)

1. Great crested grebe	7. Yellowlegged button quail	13. Brownheaded gull
2. Blacknecked grebe	8. Greyheaded lapwing	14. European nightjar
3. Lesser flamingo	9. Ringed plover	15. Eastern calandra lark
4. Siberian crane	10. Kentish plover	16. Isabelline wheatear
5. Scaup duck	11. Lesser sand plover	17. Spanish sparrow
6. Hen harrier	12. Terek sandpiper	

TABLE 2

BIRDS SEEN BY ALI (1939) NEAR KARERA BUT NOT SEEN DURING THE PRESENT STUDY

Species	Place	Species	Place
1. Painted spurfowl	Narwar Fort	16. Jungle wren-warbler	Narwar, Badarwas
2. Common bustard quail	Surwaya, Badarwas	17. Booted warbler	Surwaya
3. Bluebreasted banded rail	Satanwara	18. Olivaceous warbler	Narwar, Badarwas
4. Brown fish owl	Surwaya		
5. Collared Scops owl	Narwar Fort	19. Brook's leaf warbler	Surwaya
6. Brown hawk owl	Narwar Fort	20. Plain leaf warbler	Narwar
7. Indian nightjar	Narwar Fort	21. Firecapped tit	Surwaya
8. Crag martin	Narwar Fort	22. Paddyfield warbler	Satanwara
9. Indian cliff swallow	Satanwara	23. Grasshopper warbler	Satanwara
10. Whitebellied drongo	Narwar Fort	24. Indian iora	Narwar
11. Shortbilled minivet	Surwaya	25. Rufousbellied babbler	Narwar
12. Small minivet	Narwar Fort	26. Grey tit	Narwar
13. Verditer flycatcher	Surwaya	27. Yellowcheeked tit	Badarwas
14. Whitebrowed blue flycatcher	Surwaya	28. Vinaceousbreasted pipit	Satanwara
15. Franklin's wren-warbler	Narwar Fort	29. Whitecapped bunting	Narwar, Surwaya

TABLE 3

BIRDS NOT RECORDED BY ALI (1939) FROM GWALIOR REGION BUT SEEN DURING THE PRESENT STUDY

1. Great crested grebe	21. Osprey	41. Dunlin
2. Blacknecked grebe	22. Black francolin	42. Ruff
3. Spottedbilled pelican	23. Yellowlegged button quail	43. Brownheaded gull
4. Indian shag	24. Common crane	44. Indian whiskered tern
5. Indian reef heron	25. Siberian crane	45. Cuckoo
6. Night heron	26. Demoiselle crane	46. Great horned owl
7. Lesser adjutant	27. Purple moorhen	47. Shorteared owl
8. Glossy ibis	28. Lesser florican	48. Indian jungle nightjar
9. Lesser flamingo	29. Small Indian pratincole	49. European nightjar
10. Greylag goose	30. Whitetailed lapwing	50. Bluetailed bee-eater
11. Mallard	31. Greyheaded lapwing	51. European or Kashmir roller
12. Gadwall	32. Spurwinged plover	52. Eastern calandra lark
13. Garganey	33. Eastern golden plover	53. Crested lark
14. Redcrested pochard	34. Ringed plover	54. Collared sand martin
15. Scaup duck	35. Kentish plover	55. Brown shrike
16. Honey buzzard	36. Lesser sand plover	56. Blackheaded cuckoo shrike
17. Greater spotted eagle	37. Curlew	57. Dark grey bush chat
18. Hen harrier	38. Blacktailed godwit	58. Isabelline wheatear
19. Montagu's harrier	39. Terek sandpiper	59. Spanish sparrow
20. Pied harrier	40. Little stint	

and some spectacular wildlife sanctuaries like Kanha and Bandhavgarh, not much study has been done in recent years on the avifauna of the state. Before Ali (1939), there were a few studies in the region falling in present-day Madhya Pradesh. For example, Young (1905) described some nesting birds from Mhow region and Whitehead (1911) wrote on the birds of Sehore with special reference to migration. He listed 294 species. Moss-King (1911) listed the resident birds of Saugar (Sagar) and Damoh districts. His paper was confined to the resident birds (non-breeding migrants were omitted) and does not give a true picture of the richness of birdlife of that area.

Osmaston (1921) listed 135 species seen in Pachmarhi, and later Bates (1926) gave a general account of the birdlife of Pachmarhi, but his paper is not very useful for comparison with the birdlife of other areas as he does not list all the species. In 1931 Briggs wrote on the birds of Mhow.

The same year as Ali (1939), Hewetson (1939) published a paper on the birds of Betul district and listed 158 species, but added that as "Betul district has few lakes... so the water birds are few". Later, Hewetson (1956) published a more comprehensive paper, based on 28 years of experience, on the birdlife of Madhya Pradesh. He did not include Dhar, Gwalior, Bhopal etc. (i.e. western Madhya Pradesh) which were at that time not included in the state. However, he did include certain districts of Berar which are now in Maharashtra. For another 30 years, during which the states of India were re-demarcated and tremendous ecological changes occurred, practically nothing was published on the avifauna of Madhya Pradesh, except for comments on the earlier papers (see Alexander 1957 for his comments on Hewetson's paper) or some new sight records (e.g. Ranjitsinh 1983). Only recently, Newton *et al.* (1986) published a list of birds of Kanha Tiger Reserve.

Based on the published records of the birds of Madhya Pradesh (only those districts/areas which come within the present day boundary of Madhya Pradesh are included for comparison and discussion) an interesting picture emerges. Nearly 20 species seen by me are new to the state list (Table 1). Out of these only three species – blacknecked grebe, scaup duck and Siberian crane – can be considered as rarities in India (and Madhya Pradesh). The rest are common birds seen in many parts of the country. For example, the Kentish plover which can be seen in any large marshland in India, has not been specifically recorded from Madhya Pradesh although Ali and Ripley (1968-74) have included Madhya Pradesh in the general winter distribution of this migrant. Similarly there are many birds such as the lesser flamingo, European nightjar and Spanish sparrow (see Table 1) which have not been reported earlier by Moss-King (1911), Osmaston (1921), Briggs (1931), D'Abreau (1931), Ali (1939), Hewetson (1939, 1956) or Newton *et al.* (1986) from Madhya Pradesh.

Ali (1939) during his collection trip covered an area of nearly 70,000 sq. km consisting of Dhar, Bhopal, Indore and Gwalior states. Among these former princely states, Gwalior was the biggest (40,000 sq. km) and extended up to Guna (Fig. 1). As my studies were confined to Karera Bustard Sanctuary (200 sq. km) and its immediate surroundings, it would have been futile to compare my bird list with Ali's. Therefore I have compared my checklist with the birds collected/seen by Ali near Karera, i.e. in places like Badarwas, Shivpuri, Surwaya, Satanwara, Narwar and Kuno (Fig. 1).

Ali (1939) mentioned 29 species (Table 2) which were not seen by me in the Karera region. Most of these species prefer dense shrubs and forests – habitats no longer present in the Karera Bustard Sanctuary. As mentioned earlier, the hillocks of Karera were formerly covered with trees, mainly *Anogeissus pendula,* which have been indiscriminately cut down, thus diminishing the habitat for forest-loving birds.

Another major reason why I did not see

these birds is that as our main studies were confined to the vast open scrubland between Fatehpur and Turkani, Karawwa and Baigawan (Fig. 2). Very few trips were made to the comparatively better forested Surwaya, Narwar or Badarwas areas (all outside the sanctuary) where Salim Ali did his main collection. Nevertheless, there is certainly extensive deforestation in this region which has adversely affected the distribution of birds and other wildlife. That the area was earlier heavily forested is further proved by the presence of old tiger shooting machans near rivers. These machans are now surrounded by barren land or crop fields.

Nearly 60 species of birds (Table 3) were not noted by Ali (1939) from Gwalior region. Slightly more than half (i.e. 35) are waterbirds. These may be new entrants to this area due to development of waterbodies. However, some of these waterbodies like Dihaila in Karera and Chand-pattha lake in Shivpuri are very old and must have been present during Ali's visit (though he did not mention Dihaila and probably did not visit it in 1938).

The most surprising ommissions from Ali's list are the greylag goose, gadwall, garganey teal, redcrested pochard, demoiselle crane, blacktailed godwit, little stint and ruff. These birds are fairly common winter migrants and seen in almost all the suitable waterbodies in the area. Have these birds extended their range during the last few decades? And were they not present during Ali's time? It seems unlikely because except for the greylag goose, all are widely present in India even far south, so the Gwalior region comes well within the distribution range of these migrants. As mentioned earlier, perhaps the birds are now more commonly seen in the Karera region due to development of new waterbodies and spread of agriculture (which provide some species with foraging grounds).

Among the land birds, Ali (1939) did not notice the black francolin although he saw the painted francolin. According to my observation, the former is more common than the latter in Karera region. Again the question arises: has the painted francolin diminished in numbers due to habitat modification while the black has increased? According to Ali and Ripley (1968-74), the black francolin "affects well-watered tracts – high grass and tamarisk jungle bordering rivers and canals with alternating patches of cultivation, especially millets and sugarcane", while the painted francolin lives in "drier facies than black francolin". Increase in cultivation and better irrigation facilities in Karera must have increased the habitat of the black francolin.

In order to understand the changes in the birdlife of India due to habitat modification, J.C. Daniel (pers. comm. 1988) has suggested a study of birds of the areas where Salim Ali did his collection and field studies and a comparison of the data of his time with the present time. With birds as an indicator such studies will give a good idea about the changes which we are bringing into our environment.

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References

Alexander, H.G. (1957): Bird life of Madhya Pradesh. *J. Bombay nat. Hist. Soc. 54:* 768-769

Ali, S. (1939): The birds of central India. ibid. *41:* 82-106, 470-488.

Ali, S. & Ripley, S.D. (1968-74): Handbook of the Birds of India and Pakistan. Vols. 1-10. Oxford University Press, Bombay.

Ali, S. & Rahmani, A.R. (1982-84): Study of Ecology of Certain Endangered Species of Wildlife and their habitat. The Great Indian Bustard. Annual Report 2. Bombay Natural History Society, Bombay.

Briggs, F.S. (1931): A note on the birds in the neighbourhood of Mhow. *J. Bombay nat. Hist. Soc. 35:* 382-404.

Bates, R.S.P. (1926): Impressions of Pachmarhi Birds. ibid. *31:* 918-931.

Champion, H.G. & Seth, S.K. (1968): A revised survey of the forest types of India. Government of India Press, New Delhi.

D'Abreu, E.A. (1931): Notes on the fauna of British India: Birds chiefly with reference to the Central Provinces. *J. Bombay nat. Hist. Soc. 35:* 217-219.

D'Silva, C., Sankaran, R., Mohapatra, K.K. & Chandra, J. (1990): Indian Black Drongo *Dicrurus adsimilis* eating a bird. ibid. *87(2):* 301.

D'Cunha, E. & Akhtar, A. (1986): Mortality from a hailstorm at the Karera Bustard Sanctuary. ibid. (Centenary Suppl.) *83:* 218-219.

Hewetson, C.E. (1939): The bird year in Betul. ibid. *41:* 286-310.

Hewetson, C.E. (1956): Observations on the bird life of Madhya Pradesh. ibid. *53:* 595-645.

Moss-king, R.C.H. (1911): The Resident Birds of the Saugar and Damoh districts. ibid. *21:* 87-103.

Natarajan, V. & Sugathan, R. (1987): The Scaup Duck (*Aythya marila*) in Madhya Pradesh. *J. Bombay nat. Hist. Soc. 84* (3): 679.

Newton, P.N., Breeden, S. & Norman, G.J. (1986): The birds of Kanha Tiger Reserve, Madhya Pradesh, India. ibid. *83:* 477-498.

Osmaston, B.B. (1921): Birds of Pachmarhi. ibid.. *28:* 453-459.

Rahmani, A.R. (1987): Dihaila jheel: Conservation strategies. Tech. Report No. 12. Bombay Natural History Society, Bombay.

Rahmani, A.R. (1988a): Dihaila jheel: A new candidate for Ramsar convention. *Oryx 22:* 211-215.

Rahmani, A.R. (1988b): Protection to the great Indian bustard in Karera bustard sanctuary. *Biol. Conserv. 46(2):* 135-144.

Rahmani, A.R. (1988c): A pied harrier *Cirus melanoleucos* in northwest Madhya Pradesh. *J. Bombay nat. Hist. Soc. 85(2):* 419-420.

Rahmani, A.R. & Bhushan, B. (1985): Large Grey shrike killing a snake. *J. Bombay nat. Hist. Soc. 82(3):* 656.

Rahmani, A.R. & Manakadan, R. (1986): Interspecific behaviour of the great Indian bustard. ibid. *84:* 317-331.

Rahmani, A.R., Mohapatra, K.K. & D'Silva, C. (1990) : A Marsh sandpiper *Tringa stagnatilis* eating a frog. ibid. *87(2):* 296-297.

Ranjitsinh, M.K. (1983): Occurrence of lesser florican (*Sypheotides indica*) in Kanha National Park. ibid. *80(3):* 641.

Whitehead, C.H.T. (1911): Notes on the birds of Sehore, central India, with special reference to migration. ibid. *21:* 153-170.

Young, M. (1905): Birds nesting near Mhow, C.I. ibid. *16:* 514-516.

ON THE CAPTURE OF A GANGETIC DOLPHIN *PLATANISTA GANGETICA* ROXBURGH (MAMMALIA: CETACEA: PLATANISTIDAE) IN DUDUYA RIVER, NORTHERN WEST BENGAL[1]

MANOMAY GHOSH[2]

(With a plate and a text-figure)

One 220 cm long pregnant Gangetic dolphin, having supernumerary teeth was netted in the Duduya river, Jalpaiguri district, West Bengal on 5 December 1985. Local migration is not uncommon in this dolphin. Both the adult female and the 24.7 cm long male foetus have been described. The small size of the foetus in early December is either due to delayed conception or is suggestive of different breeding seasons in different populations of this dolphin.

INTRODUCTION

A dolphin was netted by some fishermen from the Duduya river in the village of Jhalsalbari (*c.* 26°33 45" N, 39°6 35" E), about 18 km south-east of Dhupguri, Jalpaiguri district, West Bengal. Its sudden appearance in that stream was first noticed by some fishermen towards the end of November 1985. They thought it to be a *magar machh* (gharial). They set nets on 3 December 1985 to catch the animal and captured it on 5 December. It survived for ten days in captivity. The carcass was ice-preserved by one Mintu Chowdhury, a snake-catcher of the nearby locality. The news was published in some newspapers, and generated much curiosity among local people.

The specimen was brought to Dhupguri by Chowdhury, where I examined it on 13 February 1986. Though the specimen was on the verge of putrefaction, it retained the essential morphological characters for study. It was actually a Gangetic dolphin *Platanista gangetica*.

OBSERVATIONS

The specimen (Plate 1, Fig. 1A) was an adult female, 220 cm long. The dorsal integument was slaty black and abdominal, dull to pinkish white. A portion of cranium behind the rostrum was a little exposed. As a result the flanges (maxillary crest) were visible. The dorsal fin was low. The single slit-like blowhole was longitudinal and situated above the head. The flippers were broad and almost triangular. Their outer margins were scalloped. The horizontal fluke had a notch normal in dolphins. The measurements of different body-parts agree with those of *Platanista gangetica* (Table 1). A foetus (Plate 1, Fig. 1C), which was obtained from the left uterine horn, appeared to be about three months old, and a male. It was creamy white and weighed 450 g.

Adult specimen (gravid female): From the tip of snout to the notch of the tail the body measured 214 cm. Girth of the body behind the flippers was 110 cm. Overall weight was 90 kg. Snout was more than one-fifth of the body-length and contained supernumerary pointed white teeth, having widened and flat base (Plate 1). In some of the anteriormost teeth, the roots were so widened that they came out of the sockets and were simply anchored to the gum muscle, and liable to fall off (cf. Anderson 1878, p. 438). The dental formula in the specimen was

$$\frac{32/33}{35/35}$$

The symphysis of mandible was quite long and a little more than half the length of the ramus of mandible. Eyes were minute and close to the angle of gape. The margin of blowhole was slightly elevated. The dorsal fin was small and contiguous with the low ridge behind and further away from the central point of the body.

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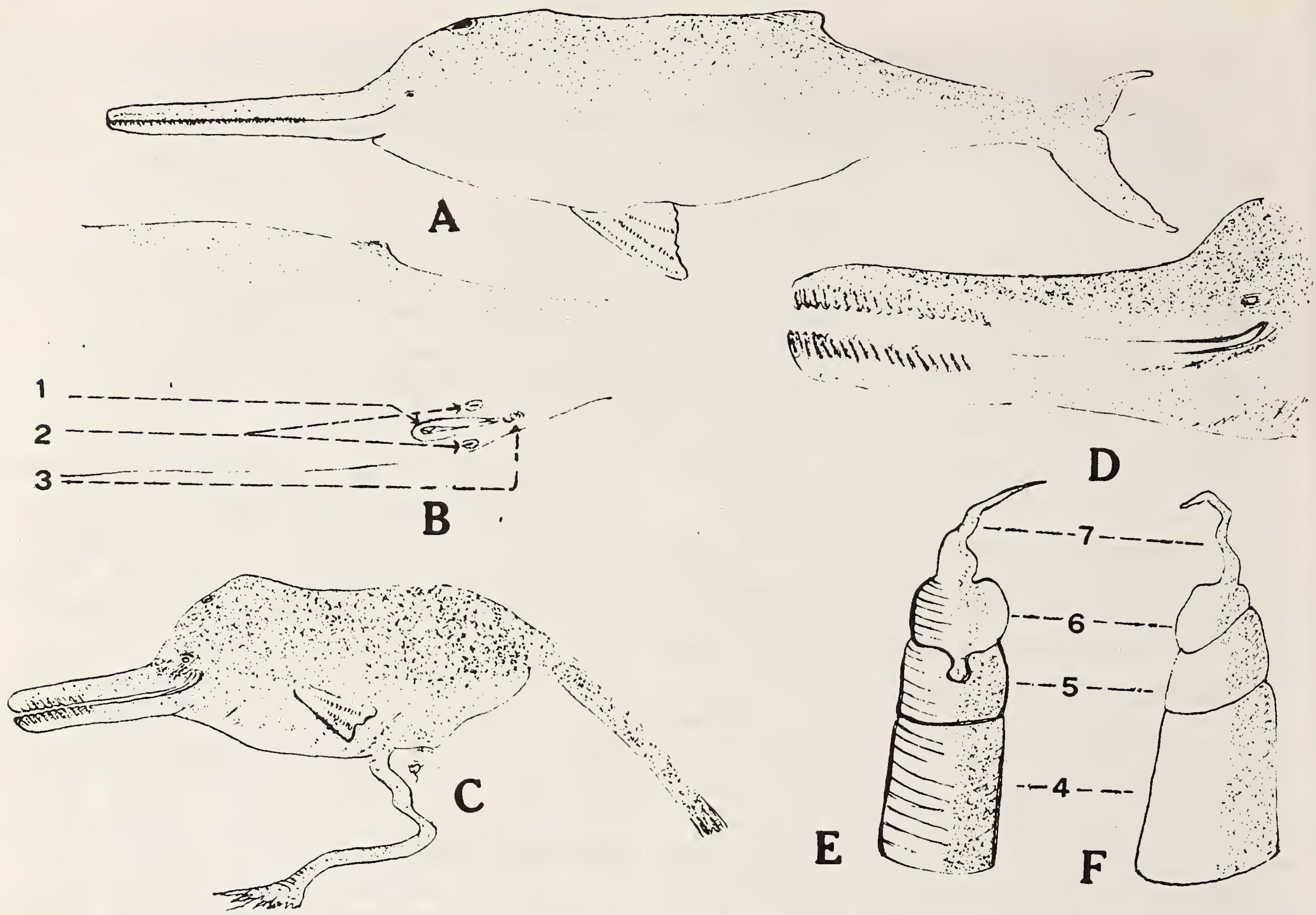
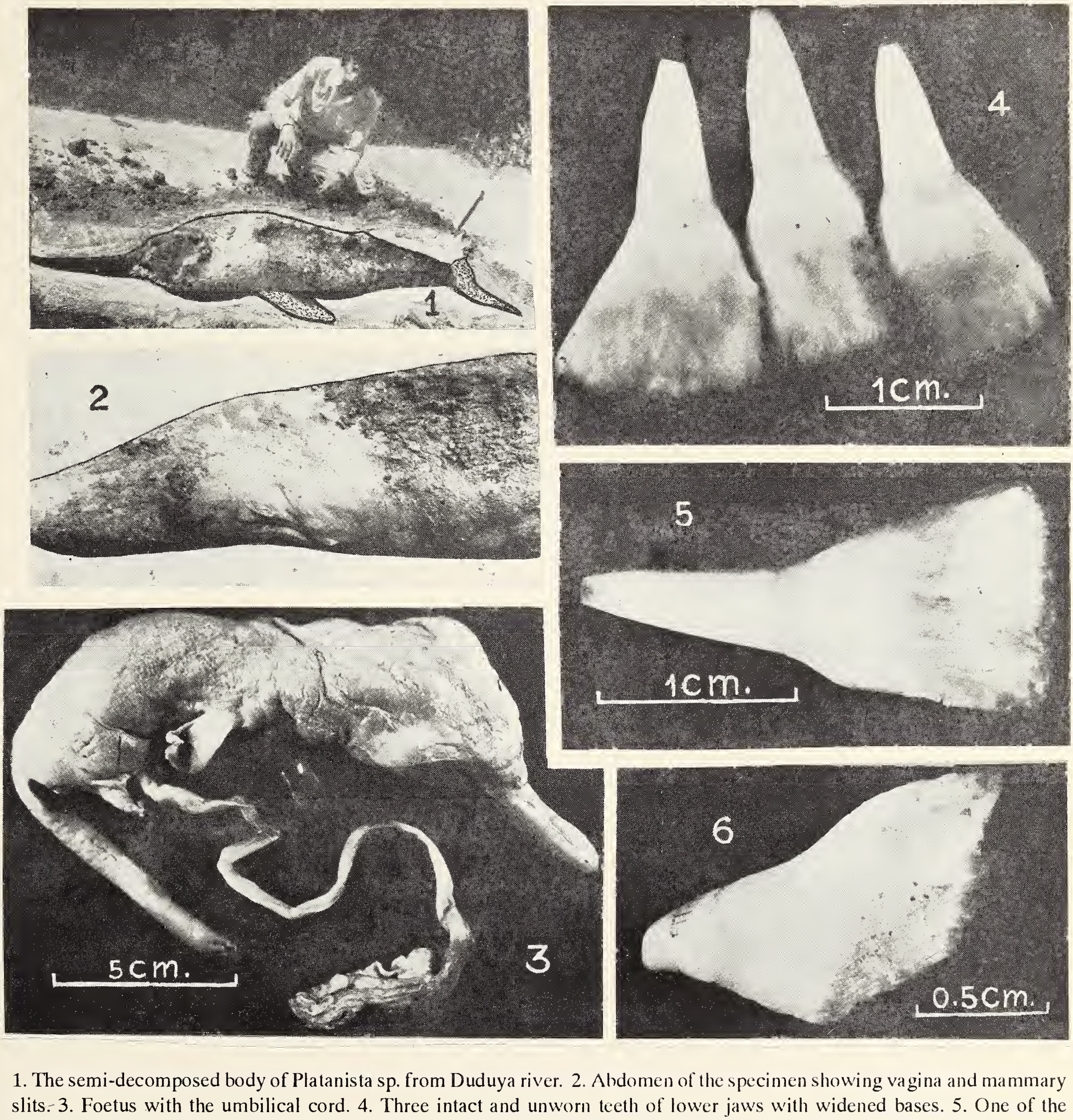


Fig. 1. A. Gangetic dolphin *Platanista gangetica*, B. Abdominal area, showing position of genital orifice (1), mammary slits (2) and anus (3). C. Foetus showing the slender tail, small flipper and urogenital organ, just caudal to umbilicus. D. Beak of the foetus, showing dental papillae. E. Protruded male genital organ of the foetus. F. Copulatory organ of ram (*Ovis* sp.): prepuce (4), collum glandis (5), galea glandis (6), processus urethrae (7).

Measurements (in cm) were as follows:

Length from snout to notch of tail			214
Length from snout to flippers			78
Length from flippers to tip of fluke			125
Length of rostrum			46
Length of rostrum at middle			5
Length of ramii of mandible			60
Symphysis of mandible			35
Flippers:	Length:	anterior	30
		posterior	15
		basal	28
Fluke:	Length:	outer	38
		expanse	40
		along notch	21
Blowhole:	Length of slit 4.2		
Vagina:	Length of orifice		12
	Distance from snout		142
Anal aperture from snout			155
Mammary:	Length of slit 1.90		
	Distance from vaginal orifice		3.50

Foetus (male): The foetus was 24.7 cm long and weighed 450 g. Beak forceps-like, long and moderately broad. In the anterior region a number of tiny dental papillae were developed within each serrated muscular groove or gum muscle (Fig. 1D). Head large and dome-shaped, blowhole aperture and minute eyes distinct. Flippers were leaf-like and distally wrinkled. The umbilical cord was a little anterior to the protruded urogenital organ. The distal part of the latter bore the urethra and



1. The semi-decomposed body of Platanista sp. from Duduya river. 2. Abdomen of the specimen showing vagina and mammary slits. 3. Foetus with the umbilical cord. 4. Three intact and unworn teeth of lower jaws with widened bases. 5. One of the anteriormost teeth, with crown slightly eroded, showing exposed pulp cavity. 6. One of the posterior most teeth with unworn crown.

penis. The tail or caudal portion was long, narrow and ventro-dorsally plano-convex. It commenced a little away from genitalia. The fluke was double-folded. Actually, both the lateral halves were folded first downward then inward, rendering the tail convex and of uniform diameter, when viewed from above.

Measurements of the male foetus (in cm) were as follows:

Length from snout to notch of tail		24.7
Length from snout to flippers		10.7
Length from snout to anal aperture		17.5
Length of snout to umbilicus 14		
Length ot snout to gape of mouth		5
Length of rostrum to maxillary crest		3.5
Mandibular ramii: Length 6		
Symphysis of mandible		3.80
Length of tail from anal aperture		7.25
Distance of anal aperture from genitalia		2
Distance of anal aperture from umbilicus		3
Head:	Length	4.2
	Breadth	5
	Height	4
	Gap between eye and blowhole	2.4
Flippers:	Length	2.5
	Breadth	1.9
	Width at base 0.8	
Fluke:	Length	2.5
	Breadth	2.5
Umbilical cord:	Length up to placenta 16	
	Average diamete	0.4
Genitalia:	Length of protruded invaginated abdominal skin	0.9
	Diameter	0.5
	Penis, including urethra	0.9

Discussion

On the basis of the first information regarding the occurrence of the dolphin from the Duduya river and its photographs, the animal was mistaken for the marine plumbeous dolphin *Sousa chinensis plumbeus*. It was hence felt desirable to make a physical examination of the specimen. The presence of maxillary crests, longitudinal blowhole, long mandibular symphysis, a constricted neck region, broad fan-like flippers and flattened dental roots (Plate 1) separate it from other dolphins and its biometry confirmed its identity as *Platanista gangetica*.

The zoo-geography and fossil evidence of related extinct species from Miocene and Pliocene marine deposits suggest that the ancestral platanistids were all marine and widely distributed. Today, only four surviving monotypic species of this group of cetacea like the lung-fishes (dipnoi) adapted their life to some of the fresh water rivers in the Indian subcontinent, China and South America. The Ganga *Platanista* used to occur plentifully in the Ganga and Brahmaputra river systems. The animal used to move through their major tributaries in Bangladesh, Assam, West Bengal, Bihar, parts of Nepal and Uttar Pradesh. It also frequently descended the tidal waters close to Bay of Bengal. Earlier it had easy access from one river system to the other through the Padma-Bhagirathi connection. But since silting up of the 2 km long connecting 'neck' of the Bhagirathi with the Padma and the construction of the Farakka barrage in 1972, the entire eastern population has been segregated into two isolated ones now confined to either of the two systems, namely the Bhagirathi-Hugli and the Brahmaputra-Padma.

Extensive fishing, increase in the deposition of silting and pollution reduced the population to a vulnerable position. Recently the animal has been included under Schedule I of Wildlife (Protection) Act 1972.

The occurrence of the adult female dolphin in the Duduya river was certainly an example of local migration. It definitely came there from the Brahmaputra system via Jamuna and Jaldhaka rivers. The animal generally avoids shallow and narrow water-courses, so under what circumstances it reached the far-off, somewhat narrow stream in Dhupguri area is not clear.

In *Platanista*, old females, with mostly decayed teeth, reach a length of 250 cm or even

more. Their symphysis becomes two-thirds the length of the ramii of the mandibles. From these points, the specimen from Duduya was not old. Its teeth were pointed and excepting a few anterior teeth (Plate 1), all had intact crowns. The teats were concealed within the tight mammary slits (Plate 1, Fig. 1B). The Gangetic dolphin reaches sexual maturity at about ten years when it grows to a length of 170-200 cm (Kasuya 1972). Therefore, it appears that the specimen under report was in her prime.

However, the supernumerary teeth in the specimen do not tally with any known figure of dentition in *Platanista*. Owen (1845) stated that there are 30 teeth on each side of the upper jaw and 32 on each side of the lower jaw. According to Anderson (1878) the dental formula for the adult Sutlej female is: upper R 32/L 33, lower R 31/L 32 and for Ganga female it is: upper R 28/L 31, lower R 30/ L 30. The dental formula attributed by Blanford (1891) for the Ganga *Platanista* is 30/30 on each side. Therefore, the dental pattern exhibited by the specimen from Duduya, which is $\frac{32/33}{35/35}$, is unique and exceeds the total number of teeth on *Platanista* recorded so far.

Foetal growth-rate in dolphins increases rapidly during five to eight months of pregnancy, when it becomes ten times that of some other mammals (Harrison and King 1980). According to Harrison (1972) the foetus in *Platanista* reaches the full neo-natal length of 70.75 cm at the time of parturition in April. The present foetus was only one-third of the mature length and from the rudimentary appendages, narrow caudal region and developing dental papillae, it appears to be three to four months old, thus placing its conception around August-September. Anderson (1878) got one almost mature male foetus measuring 72.15 cm in March 1873. If the gestation period in *Platanista* is taken as eight to nine months, as stated by Anderson (1878), then it agrees with his view that young are born during April-July. This period of par-

Table 1

External body measurements (in cm) of Gangetic dolphin from Duduya river, with those recorded by Anderson (1878), Blanford (1891) and Pilleri (1970) for comparison

	Anderson 2 Mar.1878 female specimen	Anderson female, with foetus	Blanford (1891)	Pilleri No. 11. female 83.5 kg	Pilleri No. 12. Q. female 66 kg	Adult female from Duduya river 5 Dec.1985
Tip of snout to notch of tail	257.71	243.45	222.5	240	200	214
Tip of snout to flipper	92.95	85.80	—	88	76	78
Tip of snout to angle of mouth	52.30	48.80	—	—	—	46
Length of mandible (left)	—	—	—	44	—	60
Rostrum width at mandible	—	—	—	—	—	5
Length of mandibular symphysis	—	—	—	—	—	35
Tip of snout to genitalia	—	—	—	157	140	142
Tip of snout to anus	—	—	—	162	143	155
Length of flipper	44.20	42.90	31	27	28	30
Length of fluke	50.38	46.80	—	24	23	38
Expanse of fluke	67.60	—	47	50	50	40
Length of genital orifice	15.21	11.05	—	—	—	13
Length of mammary slits	2.60	1.45	—	—	—	—
Distance of teats from genital orifice	—	3.51	—	—	—	—
Snout to dorsal fin	—	—	—	130	107	125
Length of anterior margin of dorsal fin	—	—	—	30	27	26

turition is also supported by Harrison (1972), who studied four foetuses obtained from females collected in December. The measurements given by him for these foetuses were between 42.5 cm and 54.7 cm, whereas the foetus reported here was only 24.7 cm long. The measurements of the four foetuses quoted above are confusing, as Pillery (1970), who collected the four gravid females later studied by Harrison, mentioned that the embryos in them were 25 cm long. Pillery (1971) also observed copulatory behaviour in Ganga *Platanista* in Assam in April. However, if Harrison was correct, then the foetus collected from Duduya specimen is to be considered as a case of poor development or delayed implantation. Or else, there may be two different populations of the Gangetic dolphin with different breeding seasons and somewhat different dental formulae.

The rudimentary urogenital organ in the foetus with apical S-shaped thread-like urethra and penis (Fig. 1E) resembles that of a ram (Ovinae: Bovidae). The penis which normally lies in the invaginated abdominal skin was found in the foetus studied by me to be protruded outside (Figs. 1C, E), probably due to death-shock.

It is observed while going through the literature, that adult males are proportionately less in number among captured specimens. But male foetuses obtained from gravid females are not so infrequent. Whether it is due to factors like high male mortality rate, male infanticide or some other reasons is not yet studied. However, regarding the social and nurtural behaviour of *Platanista* our knowledge is still fragmentary. It is not unlikely that the gravid female ventured out to find a safe breeding zone.

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REFERENCES

ANDERSON, J. (1878): Anatomical and Zoological Researches: Yunan Expedition, 1. London.

BLANFORD, W.T. (1891): The Fauna of British India, including Ceylon and Burma, Mammalia. Taylor and Francis, London.

HARRISON, R.J. (1972): Reproduction and reproductive organs in *Platanista indi* and *Platanista gangetica*. In: Investigations on Cetacea (ed.) G. Pilleri, 4: 71-82. Berne.

HARRISON, R.J. & KING, J.E. (1980): Marine mammals (2nd ed.). Hutchinson, London.

KASUYA, T. (1972): Some informations on the growth of Ganges dolphin with a comment on Indus dolphin. The Scientific Report of the Whales Research Institutes, Japan *24*: 82-108.

OWEN, R. (1845): Odontology, 1. Hipply-Ailliere Publication, London.

PILLERI, G. (1970): Observation on the behaviour of *Platanista gangetica* in Indus and Brahmaputra Rivers. *In:* Investigations on Cetacea (ed.) G. Pilleri. 2: 27-59. Berne.

PILLERI, G. (1971): Observations on the copulatory behaviour of the Gangetic Dolphin, *Platanista gangetica*. *In:* Investigations on Cetacea (ed.) G. Pilleei. 3: 31-33. Berne.

TAXONOMIC SIGNIFICANCE OF THE MALE GENITALIA (EPIPHALLUS) OF SOME SPECIES OF SHORT-HORNED GRASSHOPPERS (ORTHOPTERA: ACRIDOIDEA)[1]

PRASAD KUMAR AND C. A. VIRAKTMATH[2]

(With forty-six text-figures)

Comparative study of epiphallus was made on 46 species representing 40 genera of short-horned grasshoppers, and its taxonomic significance is shown. Presence or absence of dorso-lateral appendices, ancorae, oval sclerites, shape and type of bridge, ancorae and lophi of epiphallus are considered as key characters.

INTRODUCTION

Even though short-horned grasshoppers are common insects, little attention has been paid to the study of their taxonomy. A comparative study of the male genitalia has been used for identification. With this objective in view the present study was undertaken to examine the morphology of epiphallus of some species of short-horned grasshoppers of Karnataka.

Chopard (1920) was the first to introduce the structure of the male genitalia in systematics. Since then genitalia have been used as supplementary characters for the identification of species and genera (Roberts 1941, Uvarov 1943, Dirsh 1956, Kevan and Singh 1964, Hollis 1965, 1971, 1975; Mason 1973, Ritchie 1981, 1982).

Roberts (1941) studied the male genitalia of some representatives of Acrididae for an understanding of the relationship of Acrididae to other groups of Orthoptera. Dirsh (1956) studied in more detail the phallic complex of the Acridoidea and made a change in the classification of the family Acrididae. Rattanlal and Parshad (1959a, b) studied the male genitalia of certain Truxalinae and Acridinae.

MATERIAL AND METHODS

46 species under 40 genera were determined from the specimens collected from Bangalore district, Karnataka. The collected grasshoppers were identified by using pertinent literature. All identifications were later confirmed by Dr. S.K. Tandon and Dr. M.S. Shishodia, Zoological Survey of India, Calcutta.

The tip of the male abdomen was detached with the help of a microscissor and then transferred to a test tube containing a few millilitres of 10% potassium hydroxide. This was heated slowly till convection currents formed in the solution. The abdomen portion was removed to a cavity dish containing water and the digested soft tissues were pressed out with the help of bent needles. After repeated washing in water, the portion was transferred to glycerine in a cavity for removing the muscular tissues and separation of genitalic parts from the phallic complex.

The genitalia were dissected out under a stereoscopic microscope and the epiphallus transferred to a cavity slide containing a few drops of glycerine. Then illustrations were prepared using a compound microscope with a *camera lucida*. All the epiphalli were drawn from the dorsal aspect.

The terminology used in the present study is listed below and illustrated in Figs. 1 and 41. The abbreviations used are given in parentheses.

Ancorae (An): Paired hook-like structures on anterior of dorsal surface of epiphallus.

Anterior projections (Ap): Projecting anterior ends of lateral plates of epiphallus.

Bridge (Br): Middle part of epiphallus connecting its lateral parts.

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Dorso-lateral appendices (DLa): Lobes connected with the dorso-lateral parts of anterior end of epiphallus.

Lophi (Lp): A pair of processes on or near posterior end of epiphallus.

Oval sclerites (Os): A pair of small sclerites, circular, oval or irregular in form, near sides of epiphallus.

Posterior projections (Pp): Posterior ends of lateral plates of epiphallus.

Phallic a complex: Comprising the whole phallic organ of epiphallus. There are three main types of epiphallus: bridge-shaped (Figs.1-15), with divided bridge (Figs.31-34) and plate-like (Fig.16)

Results and Discussion

The epiphallus has a definite role in the taxonomy of short-horned grsshoppers. It has been used as a main character and also as a supporting character for separation of families, genera or species. The epiphallus in respect of 46 species presented are described (Figs. 1-46).

KEY TO FAMILIES OF ACRIDOIDEA
(BASED ON EPIPHALLUS)

1. Epiphallus with dorso-lateral appendices; oval sclerites absent .... Pygromorphidae
   Epiphallus without dorso-lateral appendices; oval sclerites present .... Acrididae

I. Family: Acrididae

Epiphallus usually bridge-shaped, sometimes divided; with or without ancorae; lophi of variable shape; dorsolateral appendices absent; oval sclerites present.

a) Sub-family: Acridinae

Epiphallus bridge-shaped, sometimes with central protrusion; with ancorae and single or bilobed nodulated lophi.

1. **Acrida exaltata** (Walker) (Fig. 1)

Epiphallus with moderately broad median bridge, its anterior margin convex with small paired, bilobed, nodulated lophi and blunt, peg-like ancorae.

2. **Acrotylus humbertianus** Saussure (Fig. 2)

Epiphallus with moderately wide bridge, narrow blunt end ancorae and bilobate lophi.

3. **Aiolophus thalassinus tamulus** (Fabricius) (Fig. 3)

Epiphallus with moderately narrow bridge, curvedancorae and bilobate lophi.

4. **Dittopternis venusta** (Walker) (Fig. 4)

Epiphallus with broad median bridge, ancorae broad based with rather pointed tips and bilobed lophi.

5. **Gastrimargus africanus africanus** (Saussure) (Fig. 5)

Epiphallus with comparatively large bridge, ancorae with blunt end and lophi bilobed. Ritchie (1982) used structure of lophi to distinguish the species of the genus *Gastrimargus.*

6. **Gelastorhinus semipictus** (Walker) (Fig. 6)

Epiphallus with moderately narrow bridge, comparatively large ancorae and small undivided lophi.

7. **Heteropternis respondens** (Walker) (Fig.7)

Epiphallus with stout broad bridge, convex anteriorly and concave posteriorly. ancorae with somewhat pointed tips and bent inwards and bilobed nodulated lophi.

8. **Hilethera hierichonica** Uvarov (Fig.8)

Epiphallus with narrow bridge and small, stout blunt end ancorae, anterior projection large and single lobed lophi.

9. **Locusta migratoria** (Linnaeus) (Fig.9)

Epiphallus with moderately wide bridge, blunt end ancorae, anterior projections large and large bilobate lophi.

10. **Morphacris fasciata** Kirby (Fig.10)

Epiphallus with narrow bridge, ancorae robust with blunt end, very large bilobate lophi.

11. **Oedaleus abruptus** (Thunberg) (Fig.11)

Epiphallus rectangular with narrow bridge, ancorae broad based, slender, incurved apically with blunt end and lophi bilobate.

12. **Oedaleus senegalensis** (Krauss) (Fig.12)

Epiphallus rectangular with narrow bridge,

ancorae slender, blunt end bilobate lophi. Ritchie (1981) used structure of bridge as a supporting character for separation of species of the genus *Oedaleus*.

13. **Phlaeoba panteli** Bolivar (Fig.13)

Epiphallus with narrow bridge, narrow ancorae with rounded apex, anterior projections rounded and small single lobed lophi.

14. **Sphingonotus savignyi** Saussure (Fig.14)

Epiphallus rectangular with moderately narrow bridge, ancorae large with subacute apex and bilobed lophi.

15. **Trilophidia annulata** (Thunberg) (Fig.15)

Epiphallus with narrow bridge, ancorae short with rounded apices, lophi large and bilobed and posterior lobes with a shallow excavation. Hollis (1965) separated this species from *T. conturbata* and *T. cinnabarina* on the basis of epiphallus.

b) Subfamily: Calliptaminae

Epiphallus plate-like, with ancorae and without lophi.

1. **Caloptenopsis insignis** (Walker) (Fig.16)

Epiphallus plate-like, with rather rectangular, small ancorae and without lophi.

c) Subfamily: Catantopinae

Epiphallus bridge-shaped; ancorae mostly present; lophi of variable form.

1. **Catantops karnyi** Kirby (Fig.17)

Epiphallus bridge-shaped with incurved blunt end, small ancorae and lobiform lophi.

2. **C. pinguis innotabilis** (Walker) (Fig.18)

Epiphallus bridge-shaped with large incurved, rather pointed ancorae, anterior projections large and small lobiform lophi.

3. **C. pulchellus** (Walker) (Fig.19)

Epiphallus bridge-shaped, with small incurved, rounded end ancorae and large lobiform lophi.

4. **Xenocatantops** sp. (Fig.20)

Epiphallus with wide bridge, ancorae incurved with subacute apex and large lobiform lophi.

d) Subfamily: Coptacridinae

Epiphallus bridge-shaped, with divided bridge, ancorae and lobiform lophi present.

1. **Epistaurus sinetyi** Bolivar (Fig.21)

Epiphallus with divided bridge, small blunt end ancorae and large lobiform lophi.

2. **Eucoptacrella praemorsa** (Stal) (Fig.22)

Epiphallus with divided bridge, ancorae with pointed apices and wide lobiform lophi.

e) Subfamily: Cyrtacanthacridinae

Epiphallus robust, bridge-shaped, with small or without ancorae; lophi large, lobiform.

1. **Anacridium flavescens** (Fabricius) (Fig.23)

Epiphallus robust, bridge shaped, large, elongate, lobiform lophi and without ancorae.

2. **Cyrtacanthacris tatarica** (Linnaeus) (Fig.24)

Epiphallus with elongate, narrow lobiform lophi, without ancorae and with large anterior projections.

3. **Nomadacris succincta** (Johanson) (Fig.25)

Epiphallus with wide bridge, small ancorae and large lobiform lophi.

f) Subfamily: Eyprepocnemidinae

Epiphallus bridge-shaped, mostly with poorly sclerotised bridge; curved ancorae and large lophi present.

1. **Eyprepocnemis alacris alacris** (Serville) (Fig. 26)

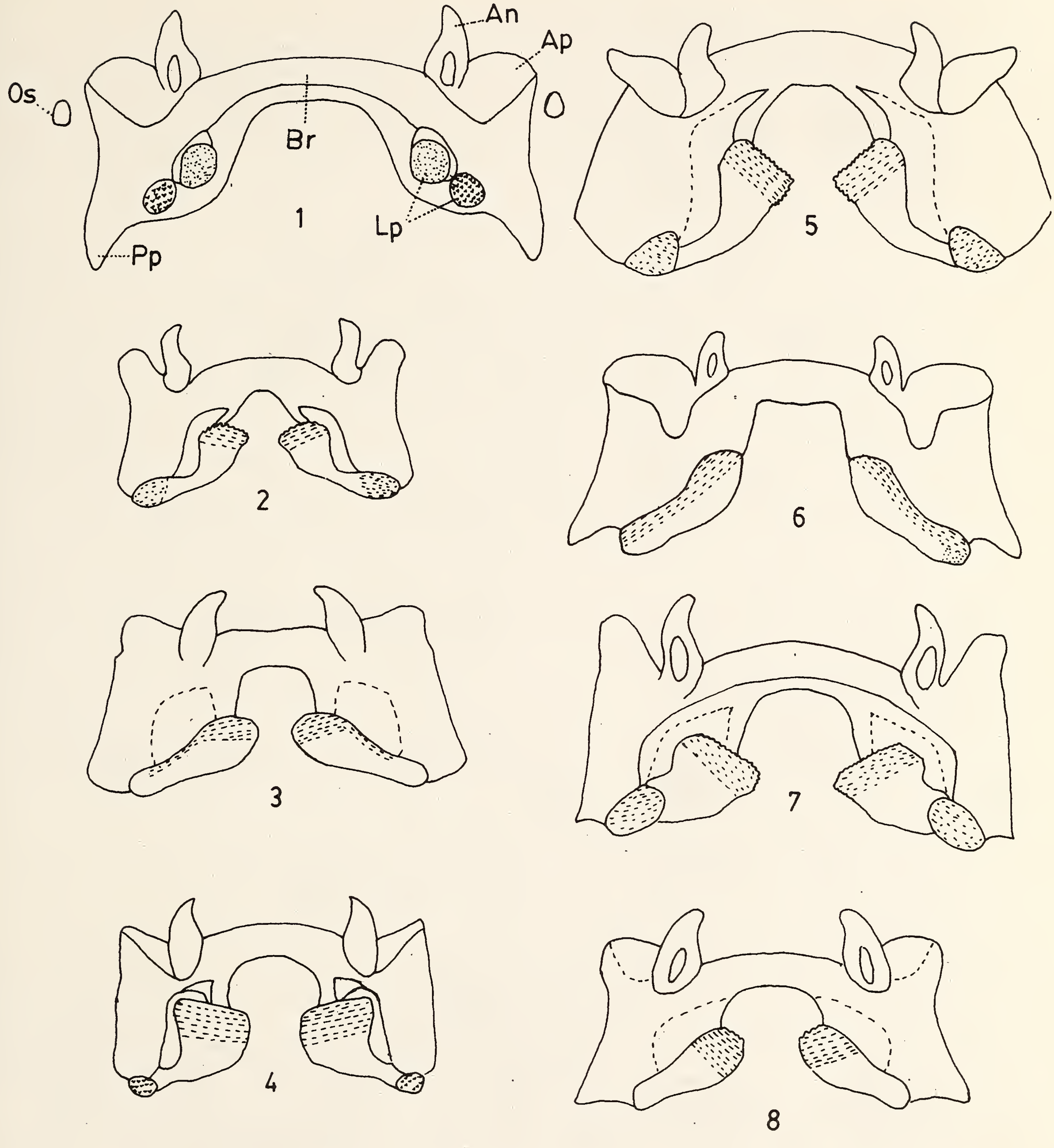
Epiphallus with narrow bridge, moderately large incurved ancorae with sub-acute apex and obtuse angular lophi.

2. **Tylotropidius varicornis** (Walker) (Fig.27)

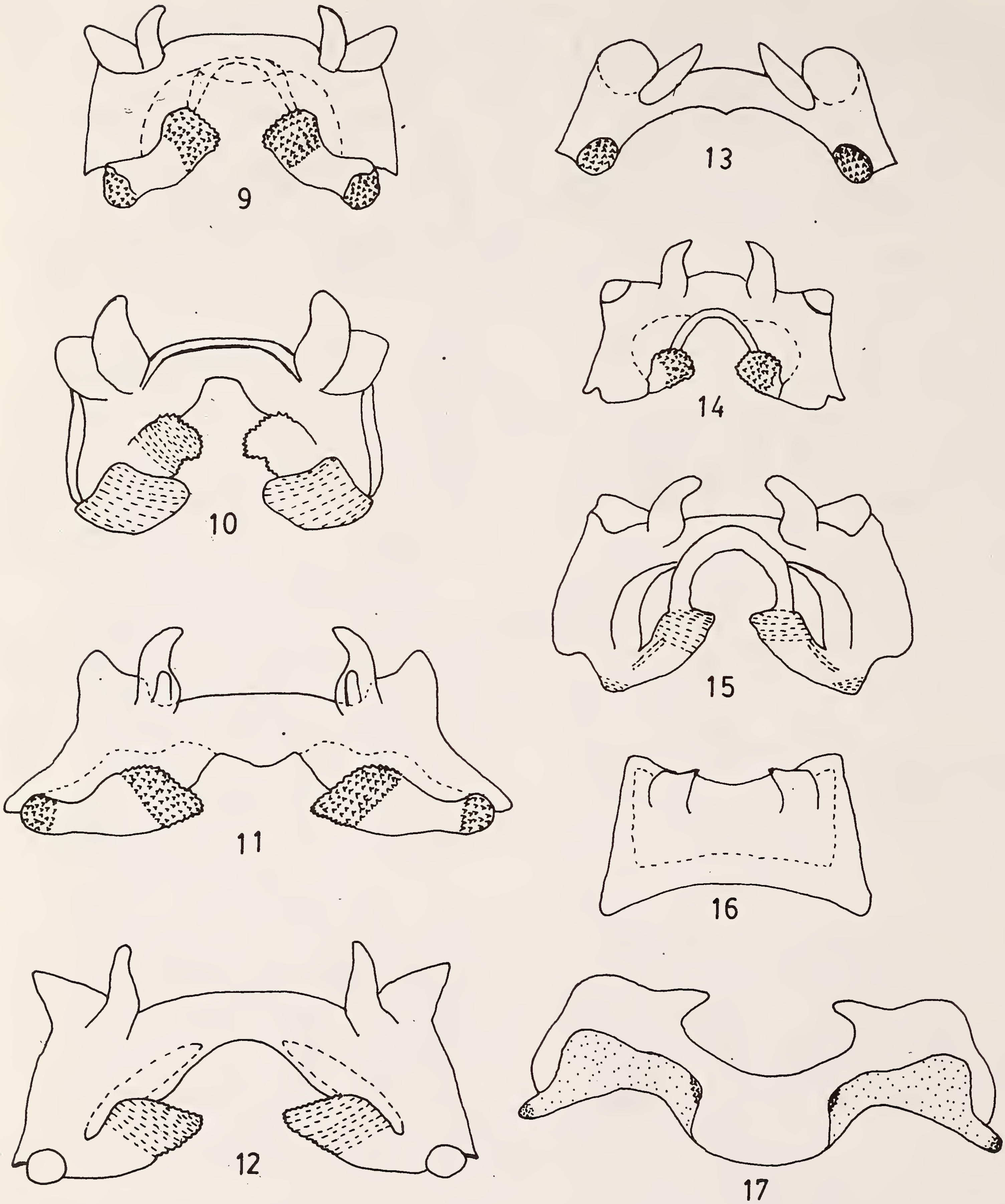
Epiphallus bridge-shaped, ancorae well developed, curved missally and rather rectangular, large lophi.

g) Subfamily: Hemiacridinae

Epiphallus bridge-shaped, sometimes with divided bridge; ancorae present; lophi of variable form.

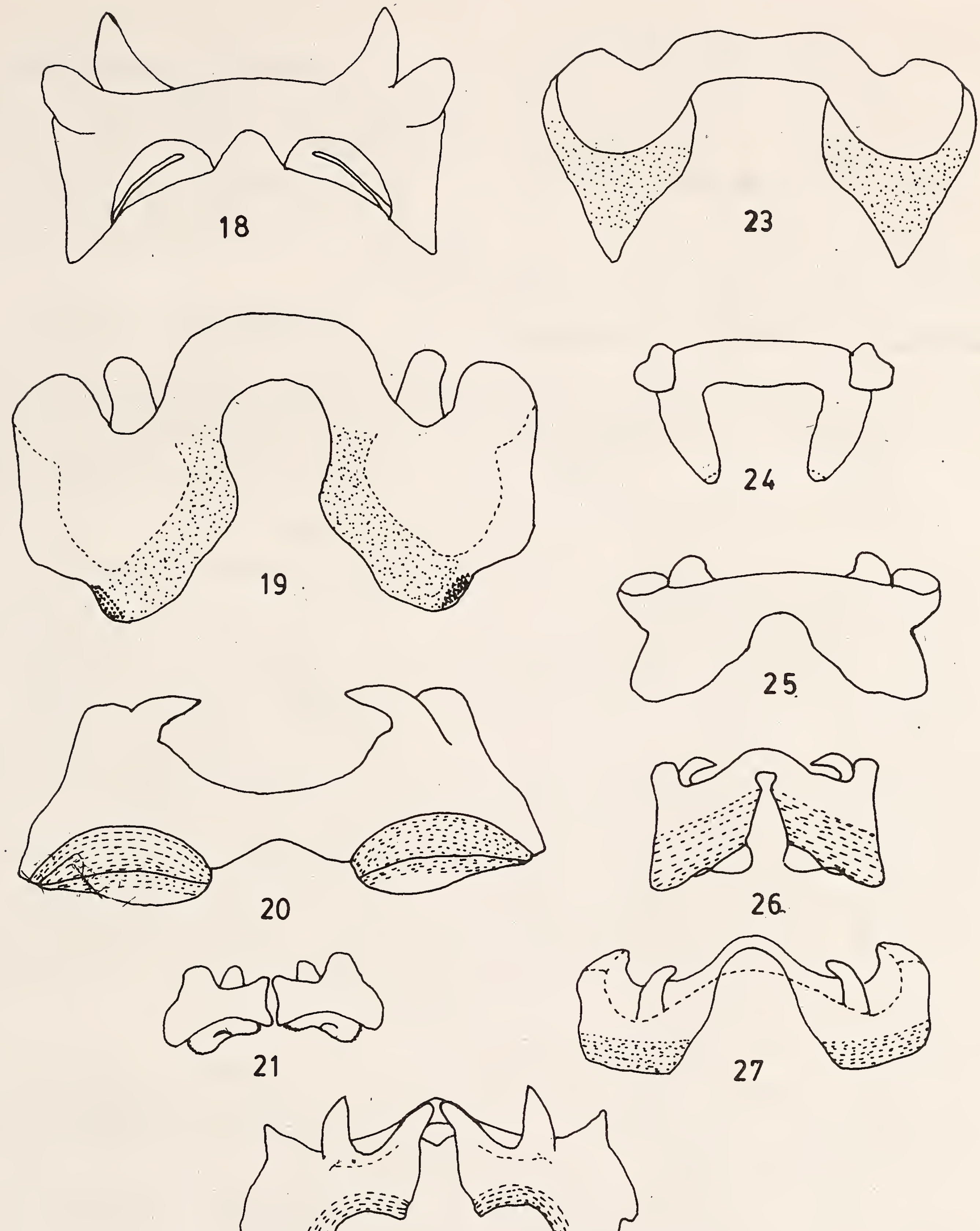


Figs. 1-8. Epiphallus in dorsal view
1. *Acrida exaltata*, 2. *Acrotylus humbertianus*, 3. *Aiolopus thalassinus tamulus*, 4. *Dittopternis venusta*, 5. *Gastrimargus africanus africanus*, 6. *Gelastorhinus semipictus*, 7. *Heteropternis respondens*, 8. *Hilethera hierichonica*.



Figs. 9-17. Epiphallusin dorsal view

9. *Locusta migratoria*, 10. *Morphacris fasciata*, 11. *Oedaleus abruptus*, 12. *Oedaleus senegalensis*, 13. *Phlaeoba panteli*, 14. *Sphingonotus savignyi*, 15. *Trilophidia annulata*, 16. *Caloptenopsis insignis*, 17. *Catantops karnyi*.



Figs. 18-27. Epiphallus in dorsal view
18. *Catantops pingus innotabilis*, 19. *Catantops pulchellus*, 20. *Xenocatantops* sp., 21. *Epistaurus sinetyi*, 22. *Eucoptacra praemorsa*, 23. *Anacridium flavescens*, 24. *Cyrtacanthacris tatarica*, 25. *Nomadacris succincta*, 26. *Eyprepocnemis alacris alacris*, 27. *Tylotropidius varicornis*.

1. **Hieroglyphus banian** (Fabricius) (Fig.28)

Epiphallus bridge-shaped with central protrusion at base, ancorae small with acute apices; lophi large with two inner lobes and sinuate outer edges. Mason (1973) used structure of lophi as a supporting character to distinguish *H. daganensis* and *H. oryzivorus*.

2. **Leptacris filiformis** Walker (Fig. 29)

Epiphallus bridge-shaped, ancorae with acute apices, lophi triangular, small, lobe-like.

3. **Spathosternum prasiniferum prasiniferum** (Walker) (Fig. 30)

Epiphallus with wide bridge, ancorae small with bluntly rounded apices and lophi small, rounded.

h) Subfamily: Oxyinae

Epiphallus with divided bridge; with or without ancorae; lophi of variable shape.

1. **Gesonula punctifrons** (Stal) (Fig.31)

Epiphallus with narrow divided bridge; well developed incurved, blunt end ancorae and complex large lophi.

2. **Oxya fuscovittata** (Marschall) (Fig. 32)

Hollis (1971) used shape of lophi and their development for the separation of species of the genus *Oxya*. Epiphallus with narrow divided bridge, without ancorae and with boot-shaped outer lophi and tooth-like inner lophi; of the latter the left lophus is always less developed than the right.

3. **Oxya hyla hyla** Serville (Fig. 33)

Epiphallus with narrow bridge; without ancorae, with curved hook-like outer lophi and with well developed tooth-like inner lophi.

4. **Oxya nitidula** (Walker) (Fig. 34)

Epiphallus with divided bridge, without ancorae, projections are well developed and with straight outer lophi and small slender inner lophi.

i) Subfamily: Romaleinae

Epiphallus robust, bridge-shaped, with short ancorae and lophi.

1. **Tetratodes monticollis** (Gray) (Fig. 35)

Epiphallus bridge shaped, robust; ancorae short and with blunt end; lophi rounded.

j) Subfamily: Tropidopolinae

Epiphallus bridge-shaped; ancorae and lophi present.

1. **Tristria pulvinata** (Uvarov) (Fig. 36)

Epiphallus bridge-shaped with central protrusion and with large incurved ancorae and large lophi.

k) Subfamily: Truxalinae

Epiphallus bridge-shaped; ancorae articulated with bridge; single or bilobed lophi.

1. **Aulacobothrus luticeps** (Walker) (Fig. 37)

Epiphallus with narrow bridge; peg-like ancorae with subacute tip; lophi bilobed, with large inner lobe.

2. **Brachycrotaphus longiceps** (Bolivar) (Fig. 38)

Epiphallus with a wide bridge; curved narrow ancorae and undivided large lophi.

3. **Leva cruciata** Bolivar (Fig. 39)

Epiphallus with broad median bridge, somewhat concave anteriorly; peg-like hollow ancorae with bluntly pointed apices; lophi bilobed with large inner lobe.

4. **Truxalis indica** (Bolivar) (Fig. 40)

Epiphallus with narrow bridge, concave posteriorly; ancorae small peg-like, broad in middle and with narrow bridge and somewhat rounded apices and with small bilobed paired lophi.

II. Family: Pyrgomorphidae

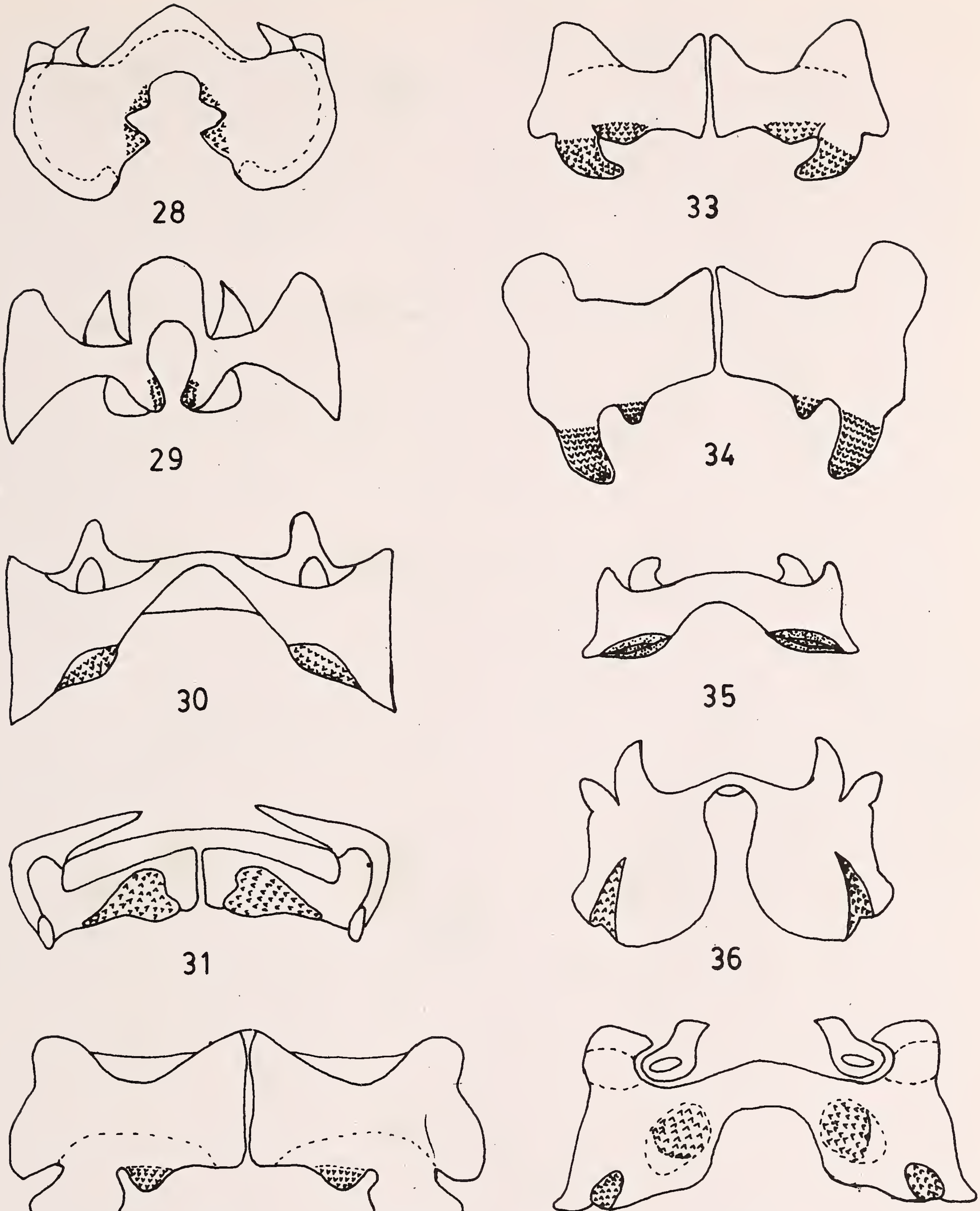
Epiphallus bridge-shaped with dorsolateral appendices: oval sclerites and ancorae absent: lophi hook-like.

1. **Atractomorpha crenuluta crenuluta** (Fabricius) (Fig. 41)

Epiphallus with middle portion anchor-shaped; dorsolateral appendices with small nodules on disc.

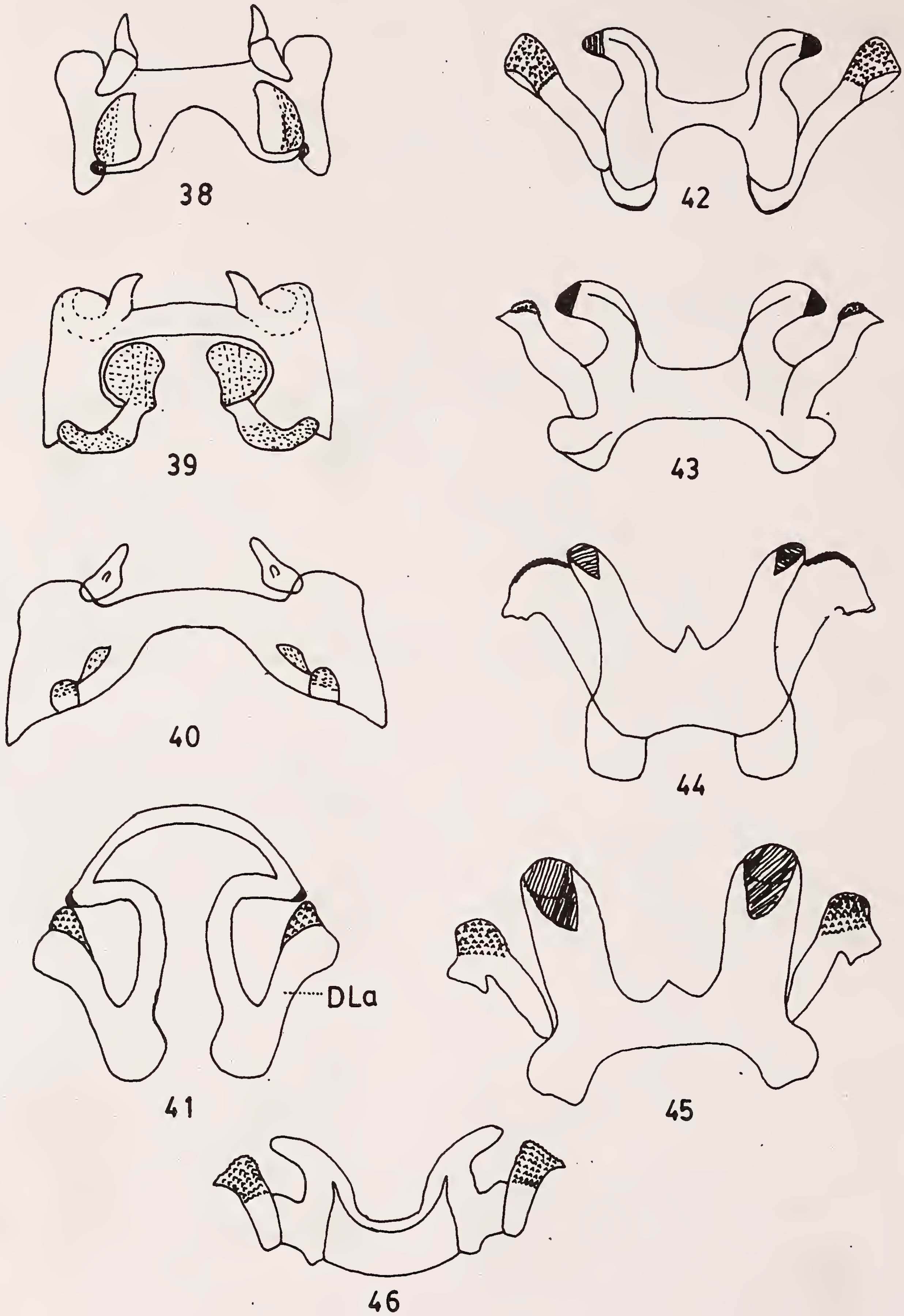
2. **Chrotogonus oxypterus** (Blanchard) (Fig. 42)

Epiphallus with strongly curved lophi, the



Figs. 28-37. Epiphallus in dorsal view

28. *Hieroglyphus banian*, 29. *Leptacris filiformis*, 30. *Spathosternum prasiniferum prasiniferum*, 31. *Gesonula punctifrons*, 32. *Oxya fuscovittata*, 33. *Oxya hyla hyla*, 34. *Oxya nitidula*, 35. *Teratodes monticollis*, 36. *Tristria pulvinata*, 37. *Aulacobothrus luticeps*.



Figs. 38-46. Epiphallus in dorsal view
38. *Brachycrotophus longiceps*, 39. *Leva cruciata*, 40. *Truxalis indica*, 41. *Atractomorpha crenulata crenulata*, 42. *Chrotogonus oxypterus*, 43. *Chrotogonus trachypterus*, 44. *Neorthacris acuticeps acuticeps*, 45. *Poekilocerus pictus*, 46. *Pyrgomorpha bispinosa bispinosa*.

disc of appendices with small nodules.

3. **C. trachypterus** (Blanchard) (Fig. 43)
Epiphallus with strongly curved lophi.

4. **Neorthacris acuticeps acuticeps** (Bolivar) (Fig. 44)
Epiphallus with small hook-like lophi.

5. **Poekilocerus pictus** (Fabricius) (Fig.45)
Epiphallus with large hook-like lophi and anterior projections.

6. **Pyrgomorpha bispinosa bispinosa** (Walker) (Fig. 46)
Epiphallus with excurved anterior margin and lophi with curved hooks.

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REFFERENCES

Chopard, L. (1920): Recherches sur la Conformation et le development des derniers segments abdominaux chez les Orthopteres. Paris.

Dirsh, V.M. (1956): The Phallic complex in Acridoidea (Orthoptera) in relation to taxonomy. *Trans. R. Ent. Soc. London. 108:* 223-356.

Hollis, D. (1965): A revision of the genus *Trilophidia* Stal (Orthoptera: Acridoidea): *Trans. R. Ent. Soc. London 117 (8)*: 245-262.

Hollis, D. (1971): A preliminary revision of the genus *Oxya* Audient-Serville (Orthoptera: Acridoidea). *Bull. Br. Mus. Nat. Hist. (Ent.) 26 (7):* 269-343.

Hollis, D. (1975): A review of the subfamily Oxyinae (Orthoptera: Acridoidea). *Bull. Br. Mus. Nat. Hist. (Ent.) 31(6):* 189-234.

Kevan, D.K. McE. & Singh, A. (1964): Preliminary diagnosis of a new genus and a new subgenus of Orghacridini (Orthoptera: Pyrgomorphidae) from South India. *Entomologist 97:* 173- 176.

Mason, J.B. (1973): A revision of the genera *Hieroglyphus* Krauss, *Parahieroglyphus* Carl and *Hieroglyphodes* Uvarov (Orthoptera: Acridoidea). *Bull. Br. Mus. Nat. Hist. (Ent.) 28(1)*: 507-560.

Rattanlal & Parshad, B. (1959a): Studies on the male genitalia of some Indian Acridinae (Acrididae: Orthoptera). *Indian J. Ent. 21(3):* 167-183.

Rattanlal & Parshad, B. (1959b): Studies on the male genitalia of certain Truxalinae (Acrididae: Orthoptera). *Indian J. Ent. 21(4):* 230-237.

Ritchie, J.M. (1981): A taxonomic revision of the genus *Oedaleus* (Orthoptera Acrididae). *Bull Br. Mus. Nat. Hist. (Ent.) 42:* 83-183.

Ritchie, J.M. (1982): A taxonomic revision of the genus *Gastrimargus* Saussure (Orthoptera: Acrididae). *Bull. Br. Mus. Nat. Hist. (Ent.) 44:* 239-329.

Roberts, H.R. (1941): A comparative study of the subfamilies of Acrididae (Orthoptera) primarily on the basis of their phallic structures. *Proc. Acad. nat. Sci. Philad.. 111:* 93.

Uvarov, B.P., (1943): The tribe Thrinchini of the subfamily Pamphaginae and the interrelations of the Acridid subfamilies. *Trans. R. Ent. Soc. London 93:* 1.

SEASONAL VARIATION IN THE MACROPHYTES OF TWO PONDS, RATHESHWAR AND TARAPUR, IN CENTRAL GUJARAT[1]

J.I. Nirmal Kumar[2], Rita Nirmal and B.C. Rana[3]

The periodic fluctuations of aquatic vegetation were studied in two ponds, Ratheshwar and Tarapur. The enrichment of three categories of 15 plant species were recognized for Ratheshwar, where the pond water appeared fresh and clean. Only five aquatic plants were observed in Tarapur pond, where the pond water had been polluted by domestic sewage and agricultural fertilizers. The indicator function of aquatic macrophytes is discussed.

Introduction

Macrophytes are widely distributed in tropical and subtropical aquatic ecosystems. Concomitant with fertility rate of our inland water bodies, macrophytic infestation has reached an alarming state. The majority of water bodies, particularly shallow water bodies, are partly or wholly covered by one or more macrophytes (Varshney and Rzoska 1973). These macrophytes play an important role in energy input, nutrient budget and recycling of nutrients in the water bodies (Howard-Williams and Junk 1977, Mickle and Wetzel 1978, Rana and Nirmal Kumar 1988). Macrophytes are pollution abatement and pollution indicators of water bodies (Shashikant 1978, Kaul *et al.* 1980). Production studies of macrophytes in India are meagre (Kaul 1977, Pandya and Kaul 1976, Sharma and Gopal 1977, Gopal and Sharma 1978, Adoni and Yadav 1985).

Very few attempts have been made to study or survey the occurrence of aquatic vegetation in Gujarat (Mirashi 1957, Chavan and Sabnis 1961, Inamdar 1968). An attempt has been made in the present investigation with a view to study the seasonal variation and make some observations on vegetational characters of certain aquatic plants in two ponds of central Gujarat.

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Study Area

Ratheshwar pond: The pond is situated in Periage, about 45 km south-west of Anand in Matar taluka of Kheda district. It is 33 hectares in area and has a depth of about 4-5 m. The main water source is a fresh water channel of Nav Talav. The water is used for drinking, washing and household purposes by the surrounding villagers. Three stations were marked from where plants were collected and checked during the present investigation: (1) at the outflow of water, (2) where the organic pollution and human activities are more, and (3) at the inflow of the water to the pond, where contamination is less than at the other two stations.

Tarapur pond: The pond is situated in Tarapur village, about 35 km south-west of Anand in Khambhat taluka, Kheda district. The water surface is about 8-9 hectares in area and has a depth of 2.5-3.5 m. Domestic sewage, agricultural fertilizers and human activities have polluted the pond.

Material and Methods

Aquatic macrophytes were collected with the help of metallic hook and string from both ponds at the above mentioned stations, kept in polythene bags and brought immediately to the laboratory, where they were washed under tap water. The plants were treated with 10% silver sulphate (in 90% ethanol) for one minute to prevent fungal and bacterial infection. The plants were dried with blotting paper and herbarium sheets were made and identified with the

TABLE 1

SEASONAL VARIATION OF AQUATIC MACROPHYTES IN RATHESHWAR AND TARAPUR PONDS

Ponds	Macrophyte species	Habitat	Months											
			June, 1988	July	August	September	October	November	December	January, 1989	February	March	April	May
Ratheshwar	*Typha angustata*	Marshy	+	+	+	+	+	+	+	+	+	+	+	+
	Echinochloa colonum	,,	+	+	+	+	+	+	+	+	+	+	+	+
	Marsilea quadrifolia	,,	+	+	+	+	+	+	+	+	+	+	+	+
	Ipomoea aquatica	,,	+	+	+	+	+	+	+	+	+	+	+	+
	Fimbristylis ferruginea	,	+	+	+	+	+	+	+	+	+	+	+	+
	Cyperus alopecuroides	,	+	+	+	+	+	+	+	+	+	+	+	+
	Nymphoides cristata	Floating	–	–	–	–	+	+	+	+	+	+	–	–
	Potamogeton pectinatus	Sub-merged	+	+	+	+	+	+	+	+	+	+	+	+
	P. nodosus	,,	–	–	–	+	+	+	+	+	+	+	+	–
	P. crispus	,,	–	–	–	–	–	+	+	+	+	+	–	–
	Hydrilla verticillata	,,	+	+	+	+	+	+	+	+	+	+	+	+
	Najas minor	,,	+	+	+	+	+	+	+	+	+	+	+	+
	Vallisneria spiralis	,,	–	–	–	–	–	+	+	+	+	+	–	–
	Ottelia alismoides	,,	–	–	–	–	+	+	+	+	+	–	–	–
	Chara sp.	,,	–	–	–	–	+	+	+	+	+	–	–	–
Tarapur	*Echinochloa colonum*	Marshy	+	+	+	+	+	+	+	+	+	+	+	+
	Ipomoea aquatica	,,	+	+	+	+	+	+	+	+	+	+	+	+
	Eichhornia crassipes	Floating	+	+	+	+	+	+	+	+	+	+	+	+
	Hydrilla verticillata	Sub-merged	–	–	–	–	–	+	+	+	+	–	–	–
	Ceratophyllum demersum	,,	–	–	+	+	+	+	+	+	–	–	–	–

+=present, –=absent

help of published literature. The herbarium sheets are preserved in the Biosciences Department, Sardar Patel University. The seasonal variation of aquatic vegetation was noted and visual assessment of macrophytes was done during the study period at monthly intervals, and a few observations of aquatic vegetation characters were registered.

RESULTS AND DISCUSSION

Aquatic macrophytes can be grouped into three categories on the basis of their habitat. The name and periodic variations of macrophytes in Ratheshwar and Tarapur ponds are given in Table 1. Among the marshy community *Typha angustata, Echinochloa colonum* and *Marsilea quadrifolia* dominated, while *Ipomoea aquatica* and *Fimbristylis ferruginea* co-dominated. *Cyperus alopecuroides* was rare..

Typha angustata was observed throughout the year, surrounding the banks of Ratheshwar pond. It flowered during April-June. This species was dominant at Station 3 followed by Stations 2 and 1.

Echinochloa colonum was noticed in both ponds and dominated in Stations 1 and 3 at Ratheshwar. It flowers during July-September.

Marsilea quadrifolia was more dominant at

Station 1 than at Stations 2 and 3. This plant is perennial and has hard bean-shaped sporocarps borne on the petioles, which were observed in the months of February-April.

Ipomoea aquatica grows abundantly at all sites. The plant is perennial, flowering during October-January. It is propagated by deep underground roots and by seeds.

Fimbristylis ferruginea is a perennial plant very restricted in distribution, occurring only at Station 2. Flowers were noted during August to November.

Cyperus alopecuroides: Richer growth of this plant was observed at Station 2 than at Stations 1 and 3.

The second category includes floating plants, which were represented by *Eichhornia crassipes* and *Nymphoides cristata* in Tarapur and Ratheshwar ponds respectively.

Eichhornia crassipes was the most predominant, persistent and troublesome aquatic weed. It reproduces vegetatively by means of slender horizontal stolons. A new plant is surrounded by offspring which develop leaves, roots and send stolons in turn. Holm *et. al.* (1969) found that two parent plants were surrounded by 1200 offspring after 4 months. Such growth might be responsible for the complete coverage of the water surface of Tarapur pond in April-June. Flowering takes place in the months of March-June.

Nymphoides cristata: Solitary flowers were recorded during December-February. This plant was present at Station 3 only from October to March. Death and decay started thereafter.

The third category is the submerged group, which develops in deep and shallow waters. Among the submerged plants *Potamogeton* sp., *Hydrilla verticillata* and *Najas minor* dominated, while *Vallisneria spiralis* co-dominated and *Ottelia alismoides, Ceratophyllum demersum* and *Chara* sp. were of rare occurrence.

Potamogeton sp.: Three species, *Potamogeton pectinatus, P. nodosus* and *P. crispus* were recorded in Ratheshwar. Germination began during August-September and the plants flowered and fruited in December-March. Death and decay started during May-June, and was accelerated due to high temperature in these months; the plant completely disappeared by July.

P. pectinatus is perennial, but of rare occurrence during summer at Stations 1 and 2 of Ratheshwar. *P. nodosus* was common in Stations 1 and 2. It has pink flowers arranged on terminal spikes. *P. crispus* was observed during the winter at Station 3 only. Flowered (terminal spikes) in December-January. *Hydrilla verticillata* was noticed at all stations throughout the study period in Ratheshwar but only during winter in Tarapur pond. Germination started late in the rainy reason, flowering occurred in September and October and death and decay began from November.

Najas minor: Significant appearance of this plant during November-February and poor production in March-June was observed. The flowers are axillary, solitary, monoecious, and were observed in September-October at Stations 1 and 2.

Vallisneria spiralis: Dense growth of this species was observed only during winter (November-March) at Stations 2 and 3, while in other months it was completely absent. It has short male flowers and many female flowers, solitary, long and coiled. Flowering was during December-February.

Ottelia alismoides was seen during October-February and was absent during most of the study period. They were quite dominant during December-January, flowered in January and February and died thereafter. The plant was common at Station 3 only.

Ceratophyllum demersum: appeared during the cold months from August to January, and was completely absent during the summer. It was dominant during October-December in Tarapur pond only. Minute axillary, solitary flowers were noticed in November- December.

Chara sp. : Mass growth of this weed was a frequent feature at Station 3 of Ratheshwar during winter (October-February) and it was dominant from November to January. Species of this genus were absent from March to September. The erect stem was differentiated into nodes, internodes and shorter and longer slender branches. Reproduction was sexual, i.e. by antheridium (globule) and oogonium (nucule); these are very complex structures with enveloping sheath and always occurred in pairs.

A few macrophytic species were registered in Tarapur pond which might be due to the high nutrient status, temperature and entry of pollutants from surrounding localities. On the other hand, aquatic vegetation was rich in Ratheshwar, which could be due to the low nutrient status, temperature of water and availability of fresh water supply through the connection of Nav Talav. However, the composition of hydrophytes varied seasonally and the number of species was greater during winter (December-February), and poor during summer (March-June) in both the ponds.

Among the marsh plants, most species are perennial, but free floating and submerged plants are restricted to post-rainy and winter seasons only. However, some of the submerged species such as *H. verticillata*, *P. pectinatus* and *N. minor* exist throughout the year in Ratheshwar. *E. crassipes* and *T. angustata* were the most prominent species growing in Tarapur and Ratheshwar ponds respectively. The observations in the present investigation are in accordance with those of Gopal and Sharma (1978), Adoni and Yadav (1985) in certain water bodies for aquatic weeds in northern parts of India.

The occurrence of *H. verticillata*, *E. colonum* and *I. aquatica* in both ponds revealed their adaptable nature to different aquatic ecosystems, and they faced no pollution threat in these waters. *E. crassipes* and *C. demersum* were present only in Tarapur pond. It also indicates that these two species can tolerate relatively high levels of pollution (Shimoda 1984, 1986). Rana *et al.* (1990) reported that the water quality, nutrients and pollution status at Tarapur pond was higher than at Ratheshwar pond. Apart from this, the rich growth of other species was restricted to Ratheshwar. This could be the result of unpolluted nature of water.

There is a difference in the aquatic vegetation at Stations 1 and 3 of Ratheshwar. Station 1 had profuse growth of *P. pectinatus*, *P. nodosus*, *N. minor*, *T. angustata*, *M. quadrifolia* and *I. aquatica*, but rarely *H. verticillata*, whereas Station 3 was dominated by *P. crispus*, *Chara* sp., *O. alismoides*, *N. cristata* and co-dominated by *V. spiralis*, *N. minor*, *P. nodosus*, *T. angustata* and rarely *I. aquatica*, *M. quadrifolia* and a few grasses. The plant species which occurred at Station 1 might be because of partial contamination by human and cattle interference (washing, bathing etc.), and are considered to be moderately pollution-tolerant plants. In contrast, the plant communities which are present at Station 3 could be influenced by the inflow of fresh or clean water from Nav Talav which supplies drinking water to more than 35 villages. These could be considered as plants intolerant of pollution.

Hence the chemical status of the water appears to be the most vital factor, significantly influencing the general distribution of aquatic plants, but other abiotic factors such as bottom soil, physical nature of pond and fluctuations of temperature and water level greatly affected the distribution of plants within the range of chemical tolerance.

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REFERENCES

ADONI, A.D. & YADAV, M. (1985): Chemical and productional characteristics of *Potamogeton pectinatus* (Linn.) and *Hydrilla verticillata* (Royle) in a eutrophic lake. *Proc. Nat. symp. Pure and Appl. Limnology* (ed.) Adoni, A.D., *Bull. Bot. Soc. Sagar 32* : 96-105.

CHAVAN, A.R. & SABNIS, S.D. (1961): A study of the hydrophytes of Baroda and its environs. *J. Indian Bot. Soc. 40:* 121-130.

GOPAL, B. & SHARMA, K.P. (1978): Studies on wetlands in India with emphasis on structure, primary production and management. IInd International Cong. of Ecology. Jerusalem, Israel.

HOLM, L.G., WELDON, Z.W. & BLACKBURN, R.D. (1969): Aquatic weeds. *Science 166:* 699-709.

HOWARD-WILLIAMS, C. & JUNK, W.J. (1977): The chemical composition of Central Amazonian aquatic macrophytes with special reference to their role in the ecosystem. *Arch. Hydrobiol. 79:* 456-464.

INAMDAR, J.A. (1968): A study of hydrophytes and marshy plants of Tiskari in Bulsar Dt., Gujarat. *J. Guj. Univ. 11(2):* 160-168.

KAUL, V. (1977): Production and ecology of some macrophytes of Kashmir lake. *Hydrobiologia, Bucharest 12:* 63-69.

KAUL, V., TRISAL, C.L. & KAUL, S. (1980): Mineral removal potential of some macrophytes in two lakes of Kashmir. *J. Indian Bot. Soc. 59:* 108-118.

MICKLE, A.M. & WETZEL, R.G. (1978): Effectiveness of submerged angiosperm-epiphyte complexes on exchange of nutrients of organic carbon in littoral systems. I. Inorganic nutrients. *Aquatic Bot. 4:* 303-316.

MIRASHI, M.V. (1957): Hydrophytes of Umred. ibid. *36:* 394-407.

PANDYA, S.C. & KAUL, S. (1976): Analysis of freshwater ecosystems in relation to aquatic vegetation. *In:* Aquatic weeds in S.E. Asia. Dr. W. Junk Publishers, The Hague. pp. 157-161.

RANA, B.C. & NIRMAL KUMAR, J.I. (1988): Energy dispersal analysis by X-rays of certain aquatic macrophytes. *Indian J. Weed Sci. 20(1):* 46-49.

RANA, B.C., SREENIVAS, S.S. & NIRMAL KUMAR, J.I. (1990): Problems of eutrophication and weed growth in certain ponds of central Gujarat. Final Technical Report (1987-90). C.S.I.R., New Delhi.

SHARMA, K.P. & GOPAL, B. (1977): Studies on structure and primary production in *Typha* species. *Int. J. Ecol. Environ. Sci. 3:* 45-66.

SHASHIKANT (1978): Aquatic macrophytes as pollution indicators and purifiers of water. *First Bot. conference 57:* 84.

SHIMODA, M. (1984): Macrophytic communities and their significance as indicators of water quality in two ponds in the Saijo basin, Hiroshima Prefecture, Japan. *Hikobia 9:* 1-14.

SHIMODA, M. (1986): The vegetation ponds in the Oasa basin, Hiroshima Prefecture, Western Japan. *Hikobia 9:* 457-465.

VARSHNEY, C.K. & RZOSKA, J. (1973): Aquatic weeds in S.E. Asia. Dr. W. Junk Publishers, The Hague.

STATUS OF WILD ELEPHANTS *ELEPHAS MAXIMUS* (LINN.) IN CACHAR AND NORTH CACHAR HILLS, ASSAM— A PRELIMINARY INVESTIGATION[1]

Anwaruddin Choudhury[2]

(With two text-figures)

The Cachar and North Cachar hills districts of southern Assam once held large populations of wild elephants. However, habitat destruction and poaching has made them locally extinct in many areas. Though a very good elephant population still exists in Assam, in these two areas their status is vulnerable.

Introduction

The Asiatic or Indian elephant *Elephas maximus* (Linnaeus 1758) has a wide distribution throughout South and South-east Asia, extending up to Sumatra and Borneo (Freeman 1980). In Assam it is found on both banks of the Brahmaputra river. The estimated population in Assam is around 4000-4500, of which about 1770 are found in the duar and the sub-Himalayan forests on the north bank of the Brahmaputra, including about 1200 in the Manas Tiger Reserve area. In 1982 a census was conducted which covered areas eastwards up to the extreme corner of the north bank region and a total of 566 elephants were found (Choudhury undated). The estimate for the south bank is about 2200-2700, which includes 523 in Kaziranga (1984 count) and *c.*150 in Sibsagar-Jorhat area (own estimate based on field study).

The main stronghold of elephants in the south bank is Karbi Anglong with contiguous habitats in Nagaon, Golaghat (part of Sibsagar district till 1983, and that of Jorhat district till 1987) and Nagaland.

Field trips were carried out in North Cachar hills (February 1986, September 1988) and in Cachar (March 1986, February 1987, April 1988). Although the main purpose of the trips was the study of non-human primates, information and data on elephants were also collected.

Study Area

North Cachar hills District is located between 24°59′ to 25°49′N and 92°31′ to 93°28′ E. In the southern and eastern part lies the lofty Barail range, the highest hill range of Assam having some areas over 1800 m above m.s.l. The rest of the district is rugged low hilly country. The Barail range, which also forms the watershed between Brahmaputra and Barak basins, is an extension of the Himalayan chain of mountains.

Cachar district (including Karimganj, which became a separate district in 1983) is located between 24° 09′ to 25°08′N and 92°13′ to 93°16′ E. The northern side is flanked by the Barails with parts above 1600 m while the southern hills are much lower and are the northern extensions of Mizo (Lushai) hills. Some of these extensions penetrated into Cachar forming long narrow valleys like the Dhaleswari valley which forms the bulk of Hailakandi sub-division. The rest of Cachar is a plain formed by the Barak river and its tributaries.

The Dyung, Langting, Kopili, Lungding and Jatinga are the main rivers of North Cachar (N. C.) hills while Barak, Dhaleswari, Sonai, Longai, Jatinga and Jiri are the main rivers of Cachar. In Cachar there are innumerable beels (ox-bow lakes) all over the area which included Son beel, Rata beel, Bakri hawor and Chatla hawor. The climate of both the areas is tropical except for small areas on the Barails where due to the altitude it is temperate. The summers are hot and wet while the winters are generally cool and dry. Winter rains are not uncommon. The annual rainfall in N. C. hills varies from less than 1000 mm in the northern areas to more than 4000 mm in the extreme south-west and in Cachar from 2000 mm to more than 6000 mm in the extreme north-west (NATMO 1977).

[1]Accepted April 1989.

[2]Near Gate No. 1 of Nehru Stadium, Islampur Road, Guwahati, Assam 781 007.

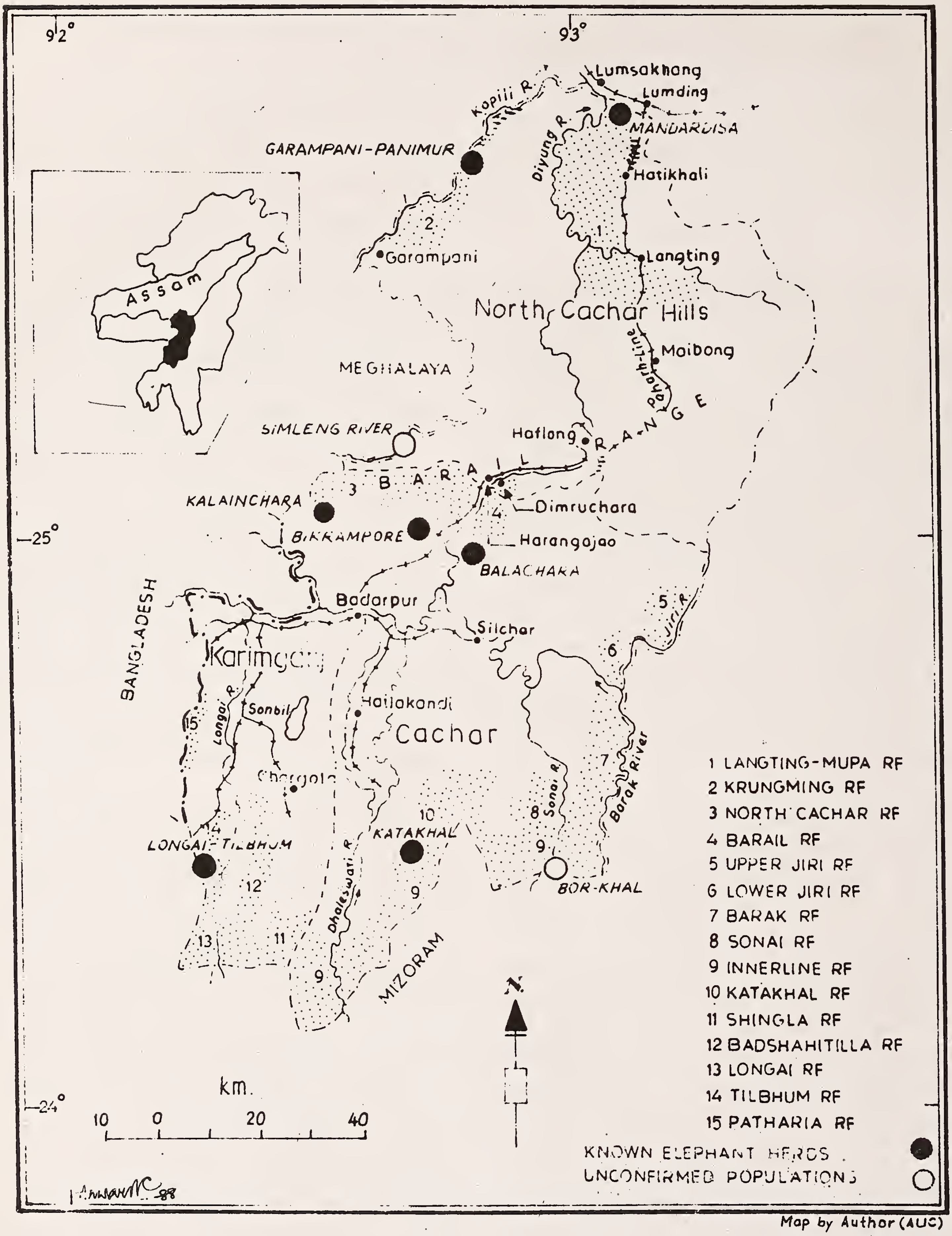


Fig. 1. Map of North Cachar Hills and Cachar (including Karimganj) showing location of main elephant populations. Dotted areas show reserved forests (RFs)

In N.C. hills wet evergreen and semi-evergreen forests occur in the Barails, western areas of Krungming RF and along nullahs and depressions in Langting-Mupa RF. The main tree species of the top canopy include *Artocarpus chaplasha, Mesua ferrea, Amoora wallichi, Michelia champaca, Mangifera* sp., *Schima wallichi, Phoebe goalparensis, Duabanga* sp., *Tetrameles nudiflora, Gmelina arborea*, etc. In the northern areas, especially in Langting-Mupa reserved forest, it is the moist mixed deciduous type which covers the bulk of the area. A good number of evergreen trees are also present. In the top canopy there are species like *Adina cordifolia, Lagerstroemia parviflora, Albizzia* sp., *Terminalia bellerica, Sterculia villosa, Salmalia malabarica, Schima wallichi, Amoora wallichii, Gmelina arborea,* etc.

The middle storey has species like *Macaranga denticulata, Bauhinia* sp., etc. Bamboo brakes occur throughout the area especially in old jhums. The main species are *Oxytenanthera nigrociliata/parviflora* (hill jati), *Bambusa tulda* (jati), *Dendrocalamus hamiltonii* and *Melocanna bambusoides* (muli). In the high altitude areas of the Barails, both in N. C. hills and Cachar occurs sub- tropical broadleaved hill forest. This forest type is generally dense and not very high. The tree species of the canopy layer include *Manglietia insignis, Schima khasiana, Cinnamomum* sp., etc. Patches of barren grassy areas also occur on the Barails.

The forests in Cachar are mostly confined to the hills and foothills and are of tropical wet evergreen and semi-evergreen types. The main tree species of the top canopy and second storey are *Palaquium polyanthum* (kurta), *Dipterocarpus turbinatus* (gurjan), *Artocarpus chaplasa, Cinometra polyandra, Mesua ferrea* (nageswar), *Eugenia* sp., *Albizzia* sp., etc. *Melocanna bambusoides* grows abundantly especially in jhums with other bamboo species like *Teinostachyum dullooa* and *Bambusa tulda.* Due to its rich floristic composition, Champion and Seth (1968) classified the forests of Cachar as 'Cachar tropical evergreen and Cachar tropical semi-evergreen forests' (Type IB/(C_3) and Type 2B/(C_2) respectively).

Results

North Cachar hills: Wild elephants were not uncommon almost throughout the northern areas of N. C. hills except in the main Barail range. Due to the steep gradient elephants avoided the main Barail range, but they frequented the foothills and sometimes moved into parts of the main range following river courses. For instance, till the early 1950s elephants were visitors to Harangajao, following the Jatinga river from Cachar. The last time elephants were seen by the local Khasi tribesmen in the area near Dimbruchara was in 1955-56. Thereafter they ceased to visit the area as in the Jatinga valley (more than 1 km wide at places) human activities like permanent paddy cultivation intensified.

Towards the north, the Langting-Mupa RF was well-known as elephant country. The moist mixed deciduous forests over low undulating hills with little gradient, all favoured elephants. When the hill section (Paharh line as it is called) of the railway line between Lumding and Badarpur was constructed in the last decade of the 19th century, confrontations between trains and elephants were a regular feature. Hatikhali (Hati = elephant), an important railway station, derived its name from elephants.

But the situation is different now. Except for a small herd of about 10-15 in the extreme north covering parts of Lamsakhang and Mandardisa Beats, there are no known elephant populations in the 493 sq. km Langting-Mupa RF. No elephants remain in and around Langting and Hatikhali proper, places which were particulary known for wild elephants. The Mandardisa herd moves regularly between Hojai area of Nagaon and Karbi Anglong districts.

Garampani-Panimur area (including Krungming RF) is perhaps the last stronghold of elephants in N. C. Hills. Though exact figures are not available, recent reports suggest that there may be about 50-60 elephants. The only other area from where confirmed reports were received is

TABLE 1
GROWTH OF POPULATION OF NORTH CACHAR HILLS AND CACHAR (INCLUDING KARIMGANJ) SINCE 1951

Year		Population	Density/ sq. km
1951	N.C. Hills	*	*
	Cachar	1116,000	160
1961	N.C. Hills	54,000	11
	Cachar	1378,000	198
1971	N.C. Hills	76,000	16
	Cachar	1713,000	246
1981	N.C. Hills	106,000	22
	Cachar	2377,000	341
1988	N.C. Hills	129,000	26
	Cachar	2914,000	419

Sources: 1951,1961, 1971, Census of India. 1981 &1988 estimates on the basis of Expert Committee on Population Projection, Registrar General & Census Commissioner, India.
*Figures not available.

from the unexplored Simleng river area bordering Jaintia hills of Meghalaya.

It may also be mentioned here that there were two outbursts of anthrax epidemic in the present century, the last one being in the mid-forties, which devastated the elephant populations of the N. C. hills (Lahiri Choudhury, pers. comm.).

Cachar: In Cachar elephants existed in the north along the foot of the Barails, and in the southern low hills, the northern extensions of which came almost upto the Barak river. But things have changed now. There are no elephants at present in the Innerline RF (1035 sq. km, the largest RF in Assam) except in the area where the Sonai river enters Cachar, where a few may exist. In Sonai, Barak and Shingla RFs too, there are no elephants. In Shingla RF one tusker was sighted in 1985 (!) by the local forest officials, but where it came from and what happened to it later are not known. Even around 1971-73 there were about 100 elephants in Shingla RF (Aziruddin, pers. comm.), but when a sugar factory came up at Chargola and its activities like sugarcane cultivation in the adjoining areas intensified, no more reports of elephants were received.

About 18 elephants still survive in the Longai-Tilbhum RFs with perhaps six more in Katakhal RF. Earlier, elephants also existed in Patharia hills RF north of Tilbhum RF, bordering Bangladesh. But no elephants were sighted by local forest officials in the area recently. The Longai-Tilbhum herd also often visits the Badshahitilla RF.

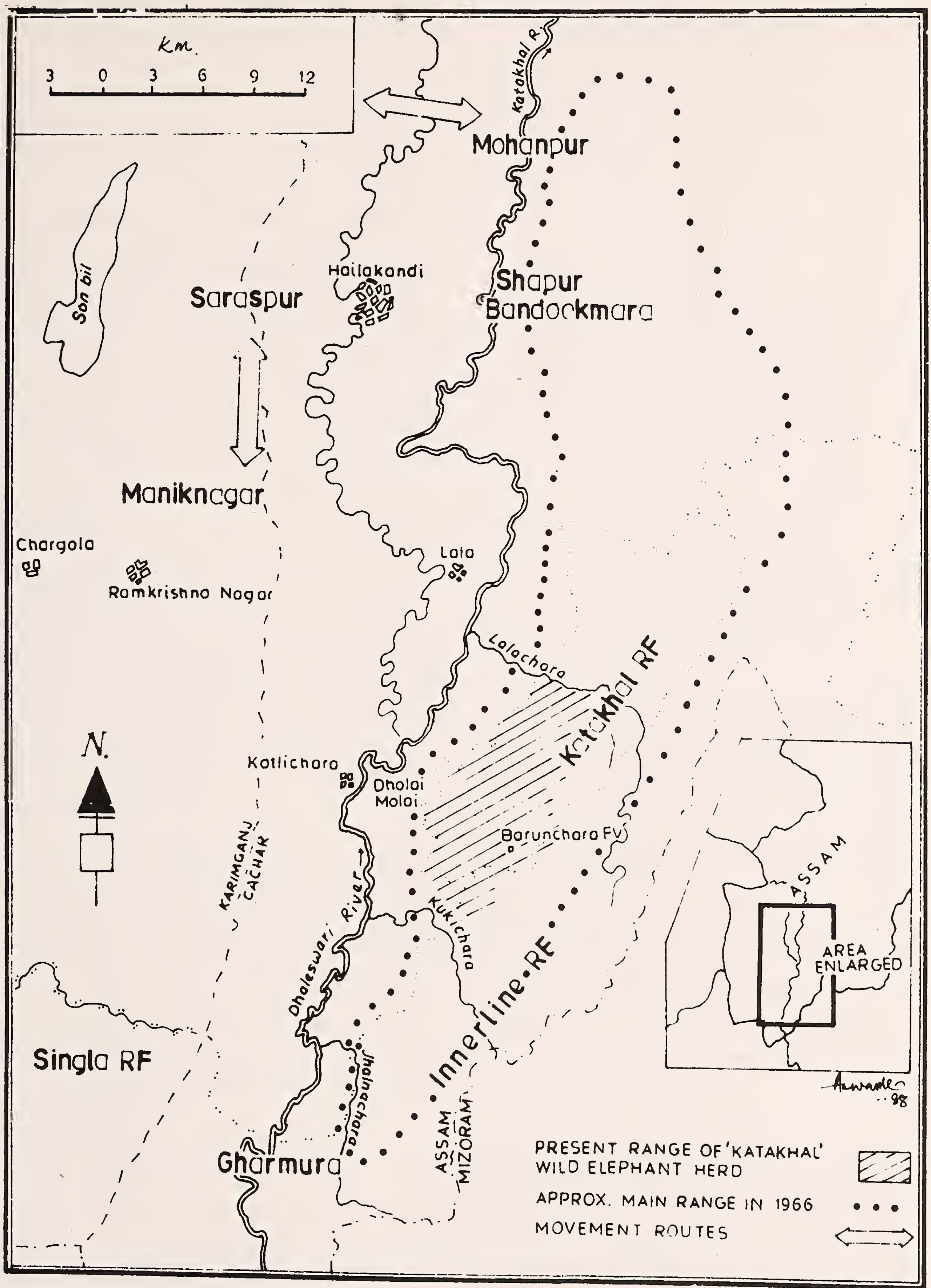
The Katakhal herd is a small one with only about 6-8 elephants. Both Katakhal and Longai-Tilbhum herds are now isolated, with no possibility, at least for the Katakhal herd, of joining the others. The herd now moves between Lalachara and Kukichara (Fig. 2). Interestingly they avoid the vicinity of the Mizoram border. In 1966 there were about 60-62 elephants in the area, i.e. the predecessors of the present Katakhal herd (Aziruddin, pers. comm.).

Some of the localities from where elephants of the Katakhal herd were captured in the past (which also reflect their movement route at that time) are Shapur-Bandookmara (1967-68), Saraspore (1972-73) and Mohanpur (1972-73); the last of the herd, reportedly 11 on the west bank of Dhaleswari river were captured at Maniknagar, north-east of Shingla RF in 1977-78 (Aziruddin,

TABLE 2
ESTIMATED ELEPHANT POPULATIONS AND DENSITY IN SOME EVERGREEN/SEMI-EVERGREEN FOREST AREAS OF ASSAM

Forest Division	Reserved Forest area in sq. km	Estimated elephant population	Density/ sq. km
1. Cachar (Cachar dist.)	1,746	50	0.03
2. Karimganj (parts of Cachar and Karimganj dist.)	607	25	0.04
3. Darrang East (parts of Sonitpur)	669	175	0.26
4. Lakhimpur (Lakhimpur)	611	104	0.17
5. Sibsagar (Sibsagar and Jorhat)	510	150	0.29
6. N.C.Hills (N.C. hills)*	618	100	0.16

Sources:1,2,5 and 6: own estimates based on field work. 3 and 4: elephant census by Forest Deptt (Choudhury undated)
* Also moist mixed deciduous. Area: North Cachar Hills 4,890 sq. km. Cachar (incl. Karimganj) 6,962 sq . km.



Map by Author (AUC)

Fig. 2. Present and recent-past ranges of the surviving wild elephant herd of Katakhal RF with earlier movement routes.

TABLE 3
MONTHLY AVERAGE MAXIMUM AND MINIMUM TEMPERATURES FOR 1978*, AND MONTHLY TOTAL RAINFALL (MEAN) FOR THE PERIOD 1983-87.

Month	Temperature in°C Maximum average	Minimum average	Rainfall (mm)
January	23.9	10.4	9.5
February	27.6	13.2	34.3
March	30.9	16.4	219.6
April	32.0	20.4	466.0
May	30.6	22.3	366.9
June	31.0	23.7	664.1
July	31.7	24.1	549.2
August	33.8	24.6	434.0
September	32.0	24.0	513.2
October	31.8	22.2	224.0
November	28.3	17.8	38.2
December	27.4	12.4	33.7
		Mean annual	3552.7

Measured at Kumbhirgram (Silchar) Airport.
Source: Meteorological Station, Guwahati.
*Due to non-availability of data for a few months between 1979 and 1985, the average could not be calculated.

pers. comm.).

During my field survey it was reported to me by an employee of Bikrampore tea garden that a herd of about 15-25 elephants regularly raid the tea estate. Bikrampore is located near the southern foot of the Barail range. Other localities of northern Cachar from where confirmed reports have been received are Kalainchara area of North Cachar RF and Balachara area just south of Barail RF. But whether the herds at Balachara and Bikrampore or Kalainchara are the same or different is not known. In July 1988 about 25-30 elephants were seen in Balachara area.

DISCUSSION

Though the elephant is in trouble in several other areas of Assam (except within sanctuaries), the situation in these two districts of southern Assam is extremely serious. While in N. C. hills habitat alteration is playing the major role, in Cachar and Karimganj it is the poaching by Mizo tribals that has caused the decline in populations.

The hill tribes of N. C. hills like the Dimasa Kacharis, Kuki groups of tribes (Hmars, Thadous, Rangkhauls, Bietes, Paites, etc.), Naga groups (Jemis, etc.) and Khasi-Jaintia tribes practise jhum or slash-and-burn shifting cultivation. Due to rapid growth of population (Table 1) the pressure on existing forest resources has also increased greatly. In southern Cachar also tribals like the Reangs, Chakmas, Mizos, Tipras (Tripuris) practise jhum.

Encroachment and tree-felling is fragmenting the habitat, thus making it unfavourable for wildlife. Moreover, there are also many forest villages inside RFs. Parts of Langting Mupa RF, south-east of Langting, are cleared in such a way for settlement that there is virtually no scope for any elephants to revisit the area. The construction of the Kopili hydel project with two dams has already destroyed good forest areas including parts of Krungming RF. A township has also grown up in Umrangsu (near Garampani), which was a well-known hunting resort.

In southern Cachar and Karimganj elephants are killed for meat. The main killers are the Mizo tribe, who relish elephant meat. Tuskers are highly sought after, being shot for both ivory and meat, and rarely attain full maturity . It may be mentioned here that Mizos are almost single-handedly responsible for pushing the elephants in this part to the verge of extinction. Some Khasis settled in the area also kill elephants whenever opportunity occurs. In N. C hills and northern areas of Cachar also, many unreported cases of poaching occur. The main tribes involved are Dimasa Kacharis, Nagas and also Mizos (Dimasa Kacharis also eat elephant-meat).In a recent case (late 1987) a wild elephant was killed by the Dimasa Kacharis by the pit method (locality not known) and later its meat was distributed in Maibong town.

A feature I observed during various field trips in different parts of Assam is that the population of elephants in southern Cachar was always proportionally much less than in other evergreen and semi-evergreen forest areas (Table 2). There are still large areas in Innerline and Katakhal RFs good enough to hold many more elephants. The small population may be due to the traditional hunting by tribals like the Mizos, which has been going on for centuries.

A recent addition to the list of disturbing agents is the massive bamboo harvesting operation for two of Asia's largest paper mills, at Jagiroad (Nagaon) and Panchgram (Cachar), each having a capacity of 100,000 tonnes per year. To ensure sustained supply of bamboo, the Hindustan Paper Corporation (HPC) has entered into a 30 year lease agreement with the Government of Assam and the Autonomous District Councils of Karbi Anglong and North Cachar hills. The forest areas leased out include the existing reserved and unclassed state forests in N. C. hills, Cachar and Karimganj.

Unless conservation measures are taken up early, within a decade the elephant may vanish completely from both the areas. Existing RFs should be given full protection and encroachment prevented. Villages in the heart of the forest should be relocated if eviction is not possible. Certain jhum control measures like rehabilitation of jhumiyas through alternative means of cultivation should be undertaken, as has been attempted by the Mizoram Government recently. Some pockets which harbour the surviving wildlife should be excluded from the lease agreement with HPC. As regards southern Cachar and Karimganj, the areas are exceptionally rich in primate resources (Choudhury 1988) and should be declared a wildlife sanctuary without further delay. Recommendations have been made on several occasions besides submitting a representation to the government (to declare the area as Dhaleswari Wildlife Sanctuary/National Park) but the state government has not taken any action.

Acknowledgements

I offer my thanks for their help during my various field trips to Monisingh, Sanga Hmar, T. K. Hmar, S. Tana Hmar, Neingaite, V. Suchiang, Laltuothang, Anwaruddin (of Jatinga), Border Roads Task Force (Jatinga Camp), Dr M. Ali Barbhuiyan, and Dr. Dubey of N. C. Hills; in Cachar to Fulmon Kurmi, Johar, Amir, Roma, Kutub, Niru and Farid Khan Choudhury. Special thanks are due to Sirai Laskar of Gharmura (Cachar) for providing food, accommodation, etc. and to Aziruddin Laskar (also of Gharmura), whose vast experience with elephants in the wild provided source material on the recent past. I would also like to thank A. K. Mazumdar, ACS, Saleh A. Choudhury, H. P. Phukan and Taher Khan Choudhury (of Hollongapar).

References

Champion, H.G. & Seth, S.K. (1968): A revised survey of the Forest Types of India. Manager of Publications, Delhi.

Choudhury, A. H. (Undated) : A report on Elephant Census (Eastern part of the North-Bank areas of Assam) carried out in winter of 1982. Forest Department, Govt. of Assam, Guwahati.

Choudhury, A. (1988): Priority ratings for conservation of Indian Primates. *Oryx 22:* 89-94.

Forest Department (Undated): Enthralling Kaziranga. Govt. Of Assam, Guwahati.

Freeman, D. (1980): Elephants, the vanishing giants. Hamlyn/Bison.

Govt. of Assam (1964) : Statistical Handbook of Assam. Dept. of Econ. and Statistics, Shillong.

Govt. of Assam (1980): Statistical Handbook of Assam. Dir. of Econ. and Statistics, Gauhati.

National Atlas and Thematic Mapping Organisation (NATMO) (1977): Water Resources, Eastern India. Plate No. 91, Calcutta..

BIOLOGY AND BEHAVIOUR OF *EUAGORAS PLAGIATUS* BURMEISTER (HETEROPTERA: REDUVIIDAE) FROM SOUTH INDIA[1]

S. J. Vennison and D. P. Ambrose[2]

(With a plate and ten text-figures)

Euagoras plagiatus Burmeister is a reduviid predator of the tropical evergreen forests of southern India. Females deposit brownish ochraceous eggs with white operculum, singly and basally cemented in 11.8 days after imaginal moult. The eggs hatch in between 4 to 9 days and the colourless nymphs acquired ochraceous colour with dark annulations on the legs within 1 hour. Total stadial period from I instar to adult ranges from 35 to 57 days. The different instars are taxonomically described and a key to nymphal instars is also given. Male and female longevities are 9 to 101 days and 8 to 86 days respectively. The sex ratio is slightly male-biased. The predatory and mating behaviours are also described.

Introduction

Reduviids constitute a large group of predatory insects that could play an important role in biological control. Our knowledge of the biology and behaviour of reduviids is inadequate. The present study outlines the biology and behaviour of a reduviid predator, *Euagoras plagiatus.*

Material and Methods

Adults of *E. plagiatus* (Figs. 1-2) were collected from shrubs in shade in tropical evergreen rain forests of Kanyakumari district, Tamil Nadu, and reared in plastic containers (6.5 cm height and 6 cm diameter) on grasshoppers (*Trilopidia* sp.), houseflies (*Musca domestica* L.) and caterpillars of *Heliothis armigera* (Hubn.). The different batches of eggs were allowed to hatch separately in plastic containers (4.5 cm height and 4 cm diameter) with wet cotton swabs for maintaining optimum r.h. (85%). The cotton swabs were changed periodically to prevent fungal attack. The hatched nymphs were separated in plastic containers and reared on the same food. Biological observations on oviposition, incubation and stadial periods, nymphal mortality, adult longevity and sex ratio were made. An index of oviposition days was calculated as the percentage of egg laying days in the total adult female's life span (Ambrose 1980). The predatory and mating behaviours were observed in adult insects kept inside the transparent rearing containers in the laboratory. For studying predatory behaviour adult predators starved up to 24 hours were used and larvae of *H. armigera* (size 15 to 20 cm long and 1.5 to 2.5 cm broad) were used as prey. For studying the mating behaviour, insects reared individually in plastic containers and aged 7 days were used. Camera lucida illustrations were prepared using specimens preserved in 70% ethanol.

Results and Discussion

Eclosion and ecdysis: The eggs (Fig.3) hatch in 4 to 9 days, invariably before 1000 hrs. The colourless nymphs become ochraceous with dark annulations on the legs within 1 hour. The nymphs do not probe the egg shells immediately after eclosion and start feeding 2 hours after emergence and prefer small and less active prey.

All the 192 nymphs observed in the laboratory moulted and emerged in the early morning before 0600 hrs. The incubation period ranged from 4 to 9 days ($\overline{X}$ = 6.2, n = 36). The stadial period of I, II, III, IV and V instars ranges from 6 to 26 days ($\overline{X}$ = 11.77, n = 88); 4 to 17 days ($\overline{X}$ = 7.4, n = 67); 4 to 19 days ($\overline{X}$ = 7.22, n = 52); 5 to 17 days ($\overline{X}$ = 8.77, n = 42); and 9 to 20 days ($\overline{X}$ = 13.37, n = 32) respective-

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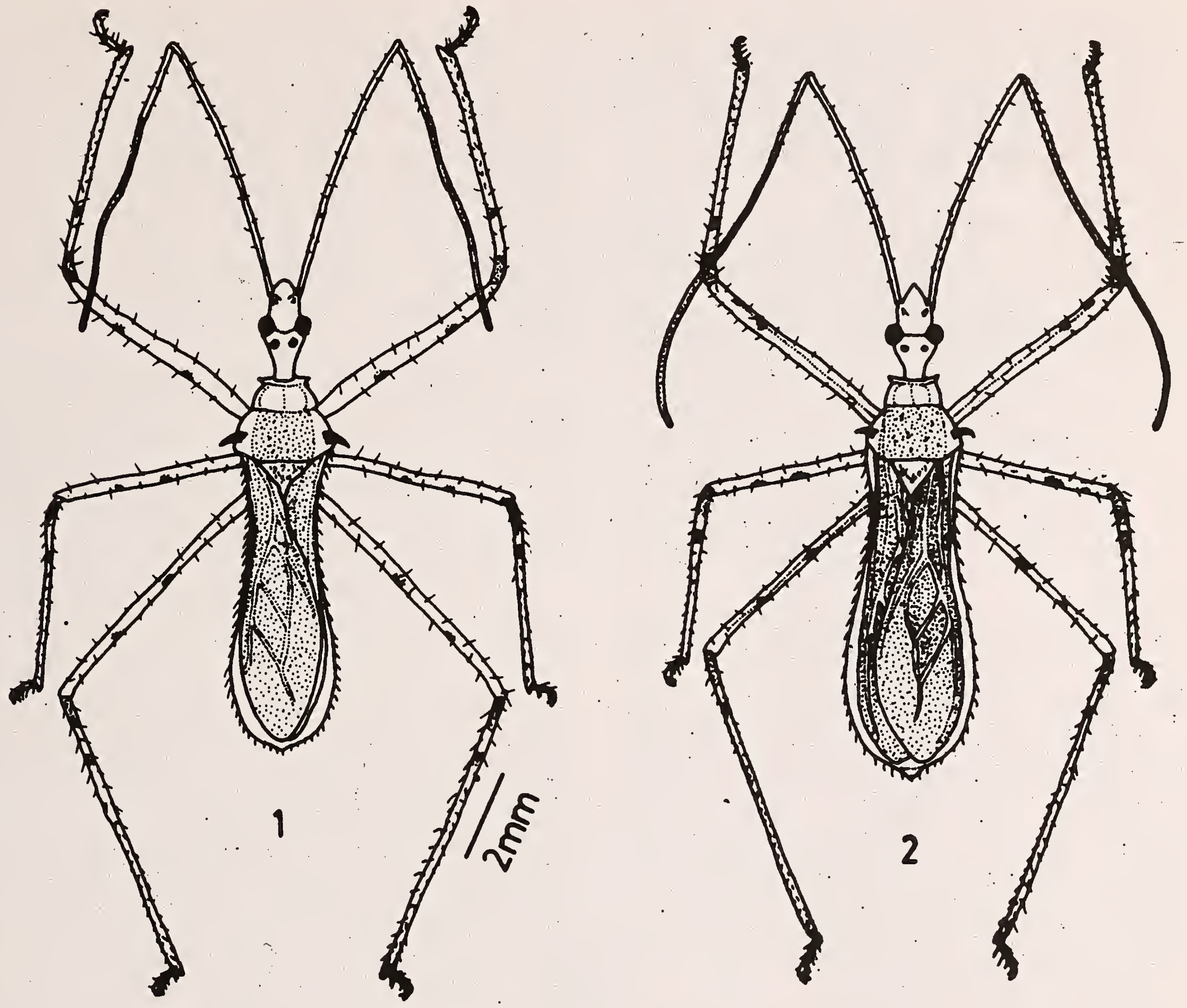
Top: Left, Female predating on a grasshopper. *Right,* Cannibalism among adults.
Bottom: Left, Male riding over female before copulation. *Right,* Embracing.



Figs. 1-2. *Euagoras plagiatus*. 1. Adult male, 2. Adult female.

ly. The total nymphal period from hatching to adult emergence ranges from 35 to 57 days ($\overline{X}$ = 48.22, n = 32). The males emerged earlier than the females.

Nymphal instars: Colour pale brownish-ochraceous; ecdysial line, anterior pronotal lobe and median abdominal dorsum and apex of abdomen ferruginous; interior of wing rudiments fuscous; annulations in the antennae, femorae, tibiae and apex of rostrum black.

Head cylindrical, ante-ocular area a little longer than post-ocular area; compound eyes slightly laterally protruded, 4 segmented antennae, long, slender, annulated and inserted near apex of head, antenniferous tubercles one on each side at the base of antenna, scape the longest, pedicel the shortest, flagellar segments filiform, finely pilose; bow shaped rostrum robust; first segment distinctly shorter than second; the third segment the shortest, scarcely pilose.

Pronotum transverse, anterolateral angles distinctly tuberculate; legs long and slender; forelegs a little longer than the shortest mid-legs; the hind legs the longest; tibiae without fossula spongiosa but with tibial comb, tarsi 3 segmented, first segment the shortest and the third segment the longest; finely pilose.

Abdomen elongate, long and sparsely pilose, ferruginous rounded spots on the fourth, fifth and sixth abdominal segments, odoriferous gland openings seen at the centre of the ferruginous spots, abdominal segmentation prominent (Figs. 4-8).

Nymphal mortality is mainly due to abnormalities during hatching and moulting. Cannibalism also causes nymphal mortality.

Adult longevity and sex ratio: The males and females live 9 to 101 days (X = 52.45, n = 17) and 8 to 86 days (X = 40.82, n = 15) respectively. Laboratory breeding experiments indicate that *E. plagiatus* is multivoltine. The sex ratio of males and females in two laboratory raised generations were 1 : 0.7 and 0.9 : 1, respectively.

Predatory behaviour: Arousal response is indicated by the unusual posture in 0.69 min. (n = 6) involving tibial juxtaposition followed by erect posture and extension of antennae towards the prey, similar to other reduviids (Ambrose 1980, 1983, Vennison and Ambrose 1987). Visual stimulus is the primary sensory input for arousal in predation. *E. plagiatus* visually locates its prey. Moving prey stimulates the predator to action (Livingstone and Ambrose 1978, Haridass and Ananthakrishnan 1980).

Once aroused, *E. plagiatus* orients towards the prey and remains motionless until the prey approaches the predator. If the prey is more agile and moves away, after a few minutes of waiting, the predator approaches the prey in 0.84 min. (n = 6) and pins it by inserting the rostrum into the membranous areas, which results in instantaneous paralysis (in 0.49 min., n = 6).

By inserting the stylets at suitable places, the prey is dragged beneath the body as the predator walks forwards or pulled while the predator moves backwards. In the field, the prey is transported to a sheltered place for interference-free feeding, whereas in the laboratory, the prey is transported to a distance of about 15 cm.

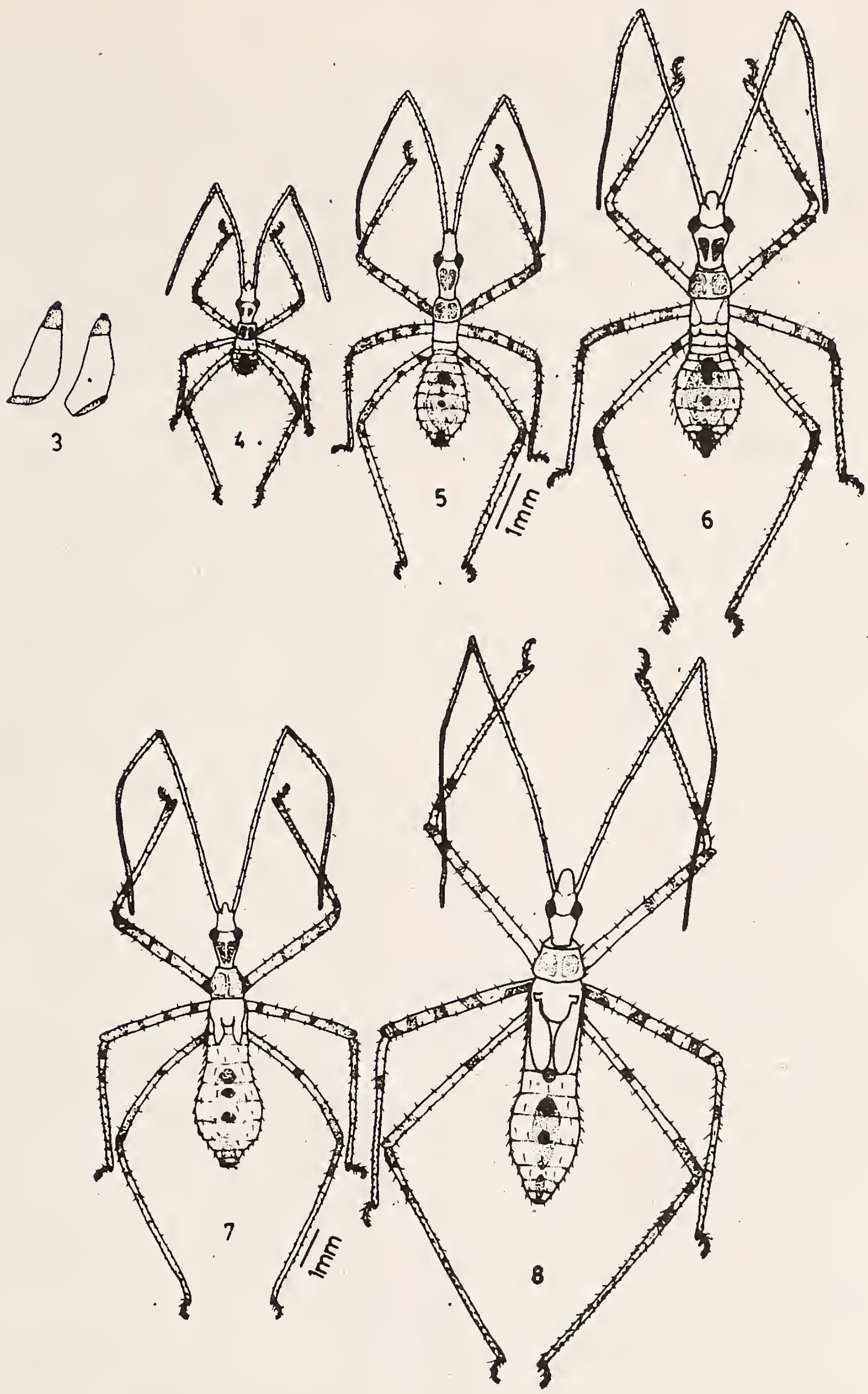
While feeding (Plate 1) the stylets are frequently withdrawn and reinserted at different angles as reported by Ambrose (1980). The secretions from the accessory salivary glands partially digest the food from the body of the prey, before being sucked in, and the secretions from the main glands digest the food after sucking (Haridass and Ananthakrishnan 1981). The entire organ system of the prey is being lysed and sucked in on an average of 74.2 min. (n = 6) and the empty exoskeleton of the prey is left behind.

E. plagiatus performs post-predatory acts, such as antennal and rostral cleaning, leg brushing etc., as reported in other reduviids by Ambrose (1980) and Vennison and Ambrose (1987). Adults turn cannibalistic when they are subjected to starvation (Plate 1).

The predatory performance can be summarised as follows : arousal – orientation – fixation – antennal extension – prey contact – rostral insertion – paralysis of prey – prey transportation – rostral thrusting and withdrawal of stylets – suction and evacuation – dropping the empty case – post predatory cleaning.

Mating behaviour: Sight appears to play a major role in sexual arousal. The arousal response is indicated by the outward thrust of antennae and tibial erection to assume a peculiar pouncing posture which is different from arousal in predation. Sex-starved males are found to arouse to mate almost instantaneously when they come close to the female in 0.32 min. (n = 6)

Males approach the females slowly with the extended rostrum and antennae (in 0.88 min., n = 6). Females on the other hand express their response by similar movements with antennal extension and rostral stridulation. They also exhibit grooming of antennae and legs and remain motionless in order to submit themselves to the approaching males. The females slowly approach the males and receive them as reported in *Acanthaspis pedestris* Stal, *Neohaematorrhophus therasii* Ambrose and Livingstone; *Coranus vitellinus* Distant, *Lophocephala guerini* Laporte,



Figs. 3-8. *Euagoras plagiatus*. 3. Eggs, 4-8. I to V nymphal instars.

KEY TO NYMPHAL INSTARS

1. Head width equal to post-ocular area, wing rudiments not visible 2
   Head width shorter than post-ocular area, wing rudiments visible. 3
2. Ante-ocular area and 2nd rostral segment equal, 2nd rostral segment equals the length of 1st and 3rd rostral segments together . . . . I instar
   Ante-ocular area longer than 2nd rostral segment, 2nd rostral segment shorter than the 1st and 3rd rostral segments together. . . . . II instar
3. Pedicel and 1st flagellar segments subequal, wing rudiments developing up to 1st abdominal segment . . . . III instar
   Pedicel shorter than 1st flagellar segment, wing rudiments developing beyond 1st abdominal segment 4
4. Length of ante-ocular area and width of pronotum almost equal, wing rudiments developing up to 2nd abdominal segment . . . . IV instar
   Ante-ocular area distinctly shorter than pronotal width, wing rudiments developing up to 4th abdominal segment . . . . V instar

Rhinocoris marginatus Fabricius and *Sphedanolestes aterrimus* Distant (Ambrose 1980, Ambrose and Livingstone 1979, 1984, Livingstone and Ambrose 1978).

After initial contact by means of antennae and legs, the male caresses the various parts of the female with his rostrum as reported by Ambrose (1980) and Ambrose and Livingstone (1984, 1985b, 1987). Then the male climbs and rides over the female (Plate 1) for several minutes (Ambrose 1980, Ambrose and Livingstone 1987).

Embracing takes place when the males keep a side-to-side position and the male embraces the partner by placing the fore and mid legs either on her left or right, the forelegs being placed over her pterothorax, the middle leg remaining free and raised (Plate 1). The males are found in dorsolateral position during nuptial clasp. Position of the males below the females as reported in *N. therasii* (Ambrose 1980) is not seen in *E. plagiatus*. The act of embracing lasts for 0.18 min. (n = 6).

The males in nuptial clasp extend their genitalia in 0.18 min. (n = 6) and achieve connection. Intermittent vibration of antennae of both partners during the entire period of copulation is a very common sight. Legs brushing, either against each other or against the substratum is a common feature. Sometimes in addition to this, the males with their hind legs brush not only their own genitals but also the thorax and the genital segments of their partner. During the entire period of copulation (35.8 min., n = 6) the male keeps himself in dorsolateral position to the female.

At the termination of mating, activities, such as legs brushing, genitalia grooming and antennal vibration slow down considerably and the antennae are kept drooping in both partners. The males lift their abdomen and thorax from the substratum faster than the females and both get separated and move off.

Post-copulatory acts, such as antennal grooming, legs cleaning and genitalia brushing by both the partners were observed (Ambrose 1980). The female after successful copulation ejects spermatophore capsule in 81.67 min. (n = 6). The aggressive post-copulatory behaviour of female over male reported in other reduviids (Ambrose 1980, Ambrose and Livingstone 1987) is seldom seen.

The sequential events of mating acts can be summarised as follows: arousal – approach – nuptial clasp – riding over – extension of genitalia and genital connection – post-copulatory acts – ejection of spermatophore capsule by female (Fig. 10).

Oviposition: *E. plagiatus* lays its first batch of eggs 11.8 days (n = 6) after emergence. Eggs are laid singly, an exception among the reported harpactorine species (Ambrose 1980, Ambrose and Livingstone 1979, 1985a, 1986a,b, Haridass 1985, 1986). Each batch consists of 1 to 12 eggs. In the laboratory, the eggs are laid on the bottom, sides as well as on the lids of the containers. The females would oviposit even on the dorsum and lateral sides of the male's thorax when reared together.

Eggs are glued basally to the substratum by means of white cementing material. Preference to glue the eggs to the fresh excreta is not observed, unlike in *A. pedestris, A. siva, A. quinquespinosa, Catamiarus brevipennis* Serville and *Edocla slateri* Distant (Livingstone and Ambrose 1978, Ambrose 1980, 1983, Ambrose *et al.* 1985, Vennison and Ambrose 1986). Guarding the eggs by either parent is not found in this species.

The eggs are elongate (1.9 ± 0.09 mm long and 0.6 ± 0.05 mm broad; n = 6) and brownish ochraceous with white operculum (0.46 ± 0.03 mm height and 0.32 ± 0.03 mm broad). The eggs are broader at the base and narrower at the apex. Anteriorly the operculum bears a knob-like portion (0.08 ± 0.02 mm long and 0.11 ± 0.02 mm broad). The chorion is polished with faint sculpturations.

A female lays 46 (n = 6) eggs in 9 (n = 6)

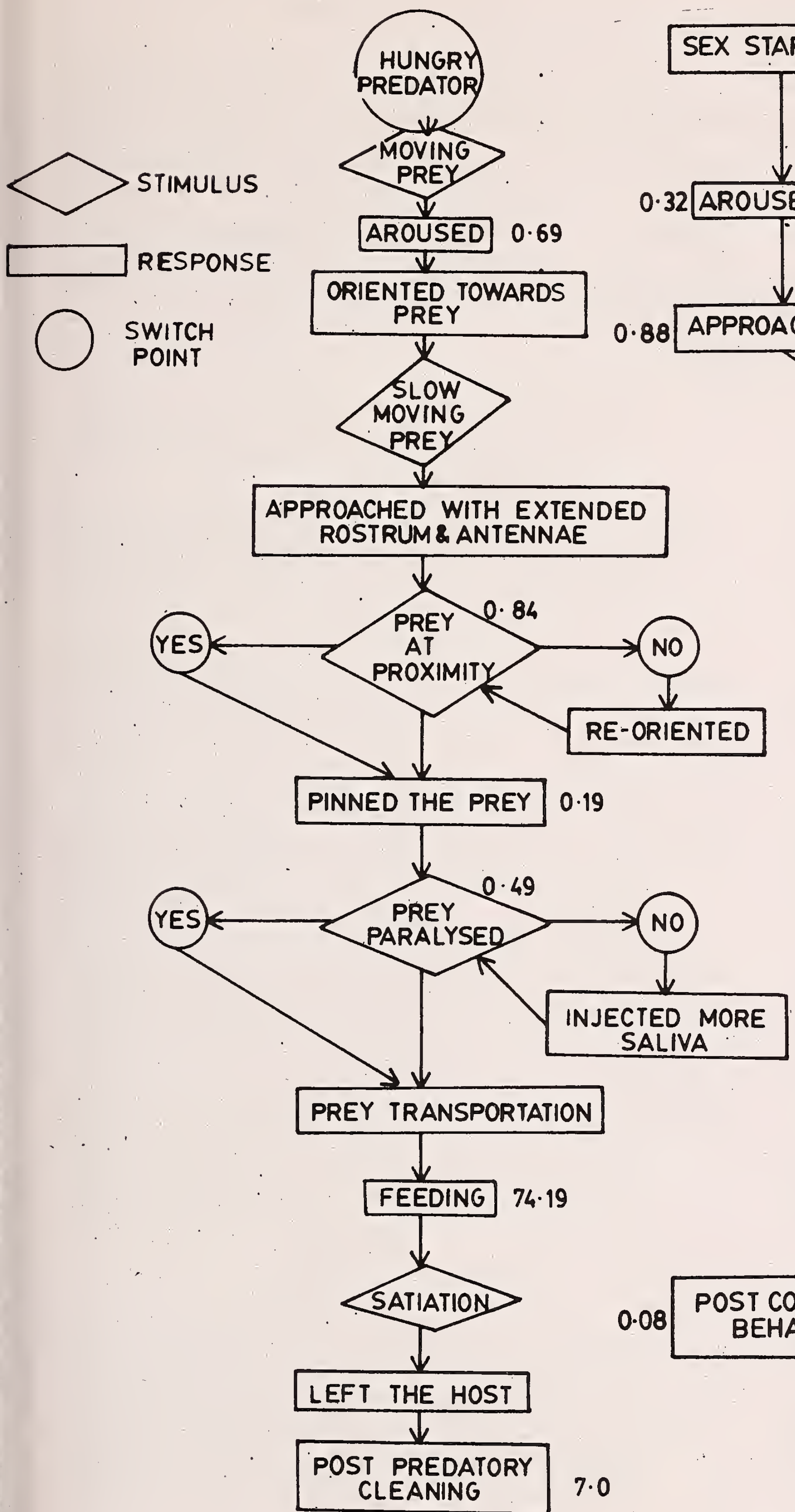


Fig. 9. Flow chart depicting predatory behaviour in *Euagoras plagiatus* (readings in min.).

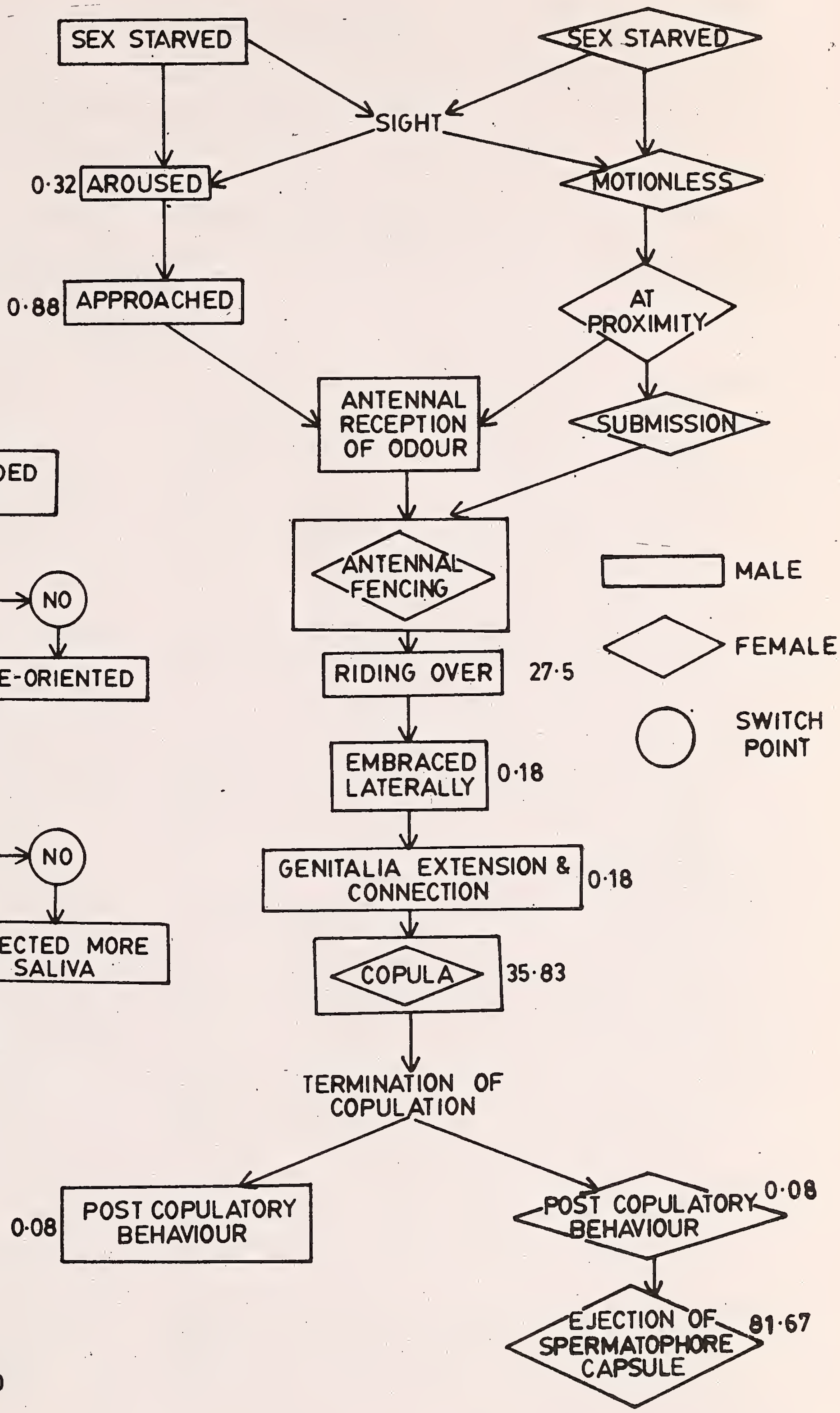


Fig. 10. Flow chart depicting mating behaviour in *Euagoras plagiatus* (readings in min.).

batches. A minimum of 1 and a maximum of 11 eggs per batch were recorded, with an average of 5 eggs per batch. The index of oviposition days was recorded as 11.8 (n = 6). Both 100% and 0% hatching were observed. A total number of 37 nymphs hatched per female and a hatching percentage of 83.59 was recorded. The unfertilized eggs were normal when laid but shrank afterwards.

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REFERENCES

AMBROSE, D.P. (1980): Bioecology, Ecophysiology and Ethology of reduviids (Heteroptera) of the scrub jungles of Tamil Nadu. Ph. D. thesis, Univ. of Madras.

AMBROSE, D.P. (1983): Biology of an alate assassin bug, *Acanthaspis quinquespinosa* (L.) Fabr. (Heteroptera : Reduviidae). *In:* S.C. Goel (Ed), Proc. symp. Ins. Ecol. & resource manage. pp. 107-115.

AMBROSE, D.P. & LIVINGSTONE, D. (1979): On the bioecology of *Lophocephala guerini* Laporte (Reduviidae: Harpactorinae), a coprophagous reduviid from Palghat Gap. *J. nat. Hist. 13* : 581-588.

AMBROSE, D.P. & LIVINGSTONE, D. (1984): Mating behaviour of two assassin bugs *Rhinocoris marginatus* Fabricius (Harpactorinae) and *Catamiarus brevipennis* Serville (Piratinae). *Proc. Indian Acad. Sci. (Anim. Sci.) 93(6):* 505-510.

AMBROSE, D.P. & LIVINGSTONE, D. (1985a): Impact of mating on adult longevity, oviposition pattern, hatchability and incubation period in *Rhinocoris marginatus* Fabricius (Insecta: Heteroptera: Reduviidae). *Environment & Ecology 3(1):* 92- 102.

AMBROSE, D.P. & LIVINGSTONE, D. (1985b): Mating behaviour and its impact on oviposition pattern and hatchability in *Acanthaspis siva* Distant (Heteroptera: Reduviidae). *Uttar Pradesh J. Zool. 5(2):* 123-129.

AMBROSE, D.P. & LIVINGSTONE, D. (1986a): Bioecology of *Sphedanolestes aterrimus* Distant (Heteroptera : Reduviidae). *J. Bombay nat. Hist. Soc. 83(1):* 248-252.

AMBROSE, D.P. & LIVINGESTONE, D. (1986b): Bioecology of *Rhinocoris fuscipes* Fabricius (Reduviidae), a potential predator on insect pests. *Uttar Pradesh J. Zool. 6(1):* 36-39.

AMBROSE, D.P. & LIVINGSTONE, D. (1987): Mating behaviour and the impact of mating on oviposition pattern and hatchability in *Rhinocoris kumarii. Environment & Ecology 5(1):* 156-161.

AMBROSE, D.P., RAMAKRISHNAN, P. & KASINATHAN, V. (1985): Biology of *Catamiarus brevipennis* Serville (Reduviidae) a predator of Bombay locust. *Uttar Pradesh J. Zool. 5:* 20-24.

HARIDASS, E.T. (1985): Feeding and ovipositional behaviour in some reduviids (Insecta : Heteroptera). *Proc. Indian Acad. Sci. (Anim. Sci.) 94(3):* 239-247.

HARIDASS, E.T. (1986): Ultrastructure of the eggs of Reduviidae II. Eggs of harpactorinae (Insecta : Heteroptera). ibid. *95(2):* 237-246.

HARIDASS, E.T. & ANANTHAKRISHNAN, T.N. (1980): Models for the predatory behaviour of some reduviids from southern India (Insecta: Heteroptera: Reduviidae). ibid. *89(4):* 387-402.

HARIDASS, E.T. & ANANTHAKRISHNAN, T.N. (1981) : Functional morphology of the salivary system in some Reduviidae (Insecta: Heteroptera). ibid. *90(2):* 145-160.

LIVINGSTONE, D. & AMBROSE, D.P. (1978): Bioecology, ecophysiology and ethology of reduviids of the scrub jungles of Palghat Gap. Part BII. Bioecology of *Acanthaspis pedestris* Stal (Reduviidae: Acanthaspidinae), a micropterous entomophagous species. *J. Madras univ. 41:* 97-118.

VENNISON, S.J. & AMBROSE, D.P. (1986): Bioecology of a dimorphic assassin bug, *Edocla slateri* Distant (Heteroptera : Reduviidae). *Entomon. 11(4):* 255-258.

VENNISON, S.J. & AMBROSE, D.P. (1987) : Predatory behaviour of two assassin bugs, *Edocla slateri* and *Oncocephalus annulipes. Environment & Ecology 5(2):* 234-238.

HAEMOGLOBIN POLYMORPHISM AND GENETIC IDENTITIES IN FIVE INDIAN COMMENSAL RODENT SPECIES[1]

M. S. Pradhan[2], A. M. Bhagwat[3] and S. T. Ingale[4]

(With two text-figures)

PAGE was used to study haemoglobin polymorphism in five Indian rodent species from Bombay-Pune region. *Rattus rattus rufescens* (Gray) showed the maximum number (15) of bands, whereas *Rattus r. wroughtoni* Hinton had only seven bands. Genetic identities pointed towards the closeness of *Rattus norvegicus* (Berkenhout) and *Bandicota bengalensis kok* (Gray). Maximum genetic distance was between *R. r. rufescens* and *R. r. wroughtoni*. The results support the earlier proposal of elevation of *R. r. rufescens* to a separate species.

Introduction

Biochemical differentiation of species specific proteins could be established by using electrophoretic techniques (Selander *et al.* 1969, Yoshida *et al.* 1971, De Smet and William 1978). We have already recorded differences in electrophoretic mobilities of haemoglobin on paper for Indian commensal rodents from Bombay-Poona region (Pradhan 1982, Pradhan *et al.* 1985); a polymorphic pattern for the inheritance of haemoglobin in rodents was established. It was, therefore, felt that the use of PAGE to resolve the haemoglobin patterns in Indian rodents may bring out additional information regarding haemoglobin polymorphism, frequency occurrence of polymorphic locii and possible genetic inter-relations. For the present study five predominantly commensal species belonging to two rodent genera, namely *Bandicota* and *Rattus*, were selected.

Material and Methods

About 91 specimens belonging to the five commensal rodent species were collected from Bombay-Pune region, Maharashtra, with the help of municipal workers. The specimens were killed for blood sample collection. The haemoglobin was separated as per the methods described by Wright (1974) while the PAGE was carried out by the method given by Zweig and Whitaker (1967) using 7.5% gels in Tris-HCL buffer. Tris-Glycin (pH 8.5) was used as electrode buffer. All the bands obtained were recorded and their mobilities were calculated in relation to that of the marker Bromophenol blue (RF values). From such individual records a common pattern for the species was evolved. The genetic identities (I) and genetic distances (D) were calculated with the help of Nei (1972). The dendrogram for the five species was constructed by unweighted pair-group arithmetic average (UPGMA) cluster analysis method (Sneath and Sokal 1973). The identification of each specimen was carried out with the help of Ellerman (1961) at Zoological Survey of India, Western Regional Station, Pune, while the PAGE was carried out at R. J. College, Ghatkopar, Bombay.

Results and Discussion

In the preliminary analysis on PAGE, haemoglobin, collected from every specimen of the five selected species, was subjected to electrophoretic separation. All the bands obtained were recorded and their mobilities were calculated in relation to that of the marker. Bromophenol blue (RF values). From such individual records a common pattern for the species was evolved. Table 1 records the relative mobilities of haemoglobin bands for the rodent species studied. The same data are represented

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as a consolidated diagrammatic haemoglobin profile for individual species (Fig. 1). Of the five different species studied *Rattus rattus rufescens* (Gray) appears to have the maximum haemoglobin polymorphism, with as many as 15 separate bands, and *R. rattus wroughtoni* Hinton the minimum, with a total of seven bands. Ferguson (1980) has suggested that the variations in the mobilities of protein (haemoglobin) bands may represent a polymorphism at gene locii regulating the synthesis of such proteins. Further, the haemoglobin molecule being a tetramer, modification at a single gene locus will give as many as five variants. It is generally accepted that among vertebrates, there are at least four gene locii regulating haemoglobin sysnthesis (Dobzansky *et al.* 1976, Fitch and Morgoliash 1970). On the basis of this assumption a total of as many as 22 bands may be expected for a haemoglobin molecule with a single alletic variation. The pattern of haemoglobin obtained in the present study also is in conformity with such an assumption.

Analysis of consolidated haemoglobin patterns for the five rodent species of two genera *Rattus* and *Bandicota* indicates that several bands have identical electrophoretic mobilities in all the species studied. This observation prompted us to calculate genetic identity (I) and genetic distance (D) (Table 2) based on allelic frequencies at each locus (Nei 1972). Based on

Table 1

HAEMOGLOBIN VARIANTS IN TERMS OF VALUES, THEIR OCCURRENCE AND FREQUENCIES IN THE POPULATIONS OF FIVE COMMENSAL RODENT SPECIES

Names of species	RF values with S.D.	No. of bands	% population (occurrence)	% frequency of bands
n=Total No. of specimens	0.1 ± —	2	6.1	2.6
	0.18 ± 0.02	3	9.1	3.8
nb=Total No. of bands	0.23 ± —	1	3.0	1.3
Rattus rattus rufescens (Gray) n=33 nb=78	0.3 ± —	2	6.1	2.6
	0.34 ± —	1	3.0	1.5
	0.38 ± —	3	9.1	3.8
	0.42 ± 0.01	4	12.1	5.1
	0.46 ± 0.02	14	42.4	17.9
	0.5 ± 0.01	8	24.2	10.3
	0.52 ± 0.01	4	12.1	5.1
	0.55 ± 0.01	10	30.3	12.8
	0.58 ± 0.01	9	27.3	11.5
	0.67 ± 0.01	13	39.4	16.6
	0.7 ± 0.01	3	9.1	3.8
	0.89 ± —	1	3.0	1.3
Rattus norvegicus (Berkenout) n=15 nb=46	0.21 ± 0.01	2	13.3	4.4
	0.25 ± 0.07	2	13.3	4.4
	0.30 ± 0.01	4	26.6	8.7
	0.34 ± 0.01	2	13.3	4.4
	0.38 ± 0.01	3	19.9	6.5
	0.45 ± 0.01	9	59.9	19.6
	0.49 ± 0.01	8	53.3	17.4
	0.53 ± 0.01	6	39.9	13.1
	0.59 ± 0.02	8	53.3	17.4
	0.65 ± —	2	13.3	4.4

Table 1 (contd.)

Names of species	RF values with S.D.	No. of bands	% population (occurrence)	% frequency of bands
Rattus rattus wroughtoni Hinton n=11 nb=22	0.4 ± —	1	9.1	4.6
	0.45 ± —	1	9.1	4.6
	0.5 ± 0.01	3	27.3	13.6
	0.53 ± 0.01	5	45.5	22.7
	0.59 ± 0.01	6	54.6	27.2
	0.63 ±0 .01	3	27.3	13.6
	0.66 ± 0.01	3	27.3	13.6
Bandicota indica indica (malabarica))(Bech.) n=13 nb=28	0.31 ± —	1	7.7	3.6
	0.36 ± 0.02	4	30.8	14.3
	0.42 ± 0.01	4	30.8	14.3
	0.46 ± 0.01	5	38.5	17.9
	0.49 ± 0.01	5	38.5	17.9
	0.53 ± 0.01	3	23.1	10.7
	0.57 ± 0.01	3	23.1	10.7
	0.62 ± 0.02	3	23.1	10.7
Bandicota bengalensis kok (lordi) (Gray) n=19 nb=44	0.32 ± —	1	5.3	2
	0.39 ± 0.01	5	26.3	10
	0.45 ± 0.01	8	42.1	16
	0.49 ± 0.01	7	36.8	14
	0.53 ± 0.01	1	57.9	22
	0.59 ± 0.01	7	36.8	14
	0.65 ± 0.01	4	21.4	8
	0.71 ± —	1	5.3	2

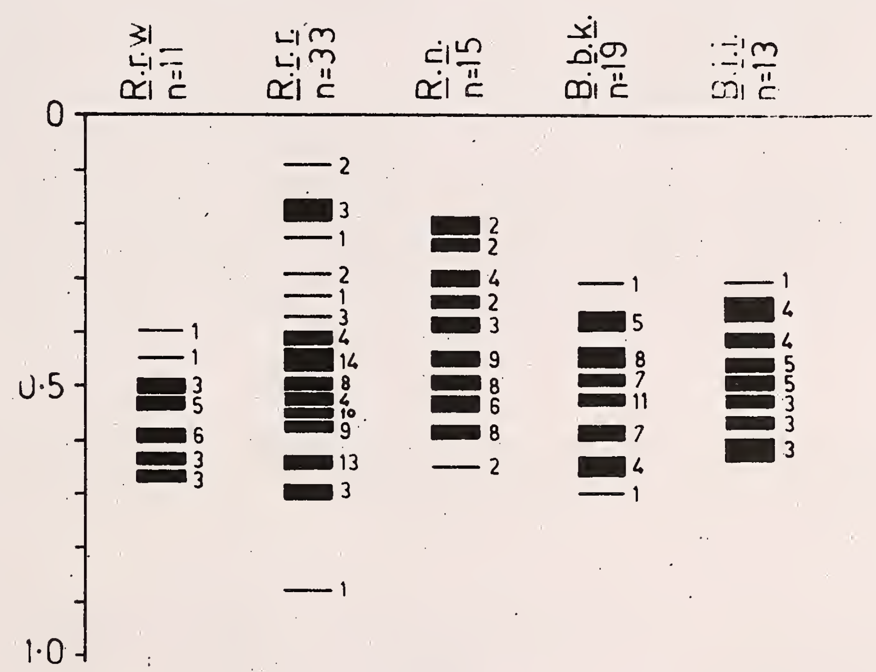

Fig. 1. Consolidated diagrammatic haemoglobin profile for individual species
R.r.w. = *Rattus rattus wroughtoni*, R.r.r. = *R. r. rufescens*, R.n. = *R. norvegicus*, B.b.k. = *Bandicota bengalensis kok (lordi)*, B.i.i. = *B. indica indica (malabarica)* , n = no. of specimens. Numbers near the bands show number of occurrences of each band in the population.

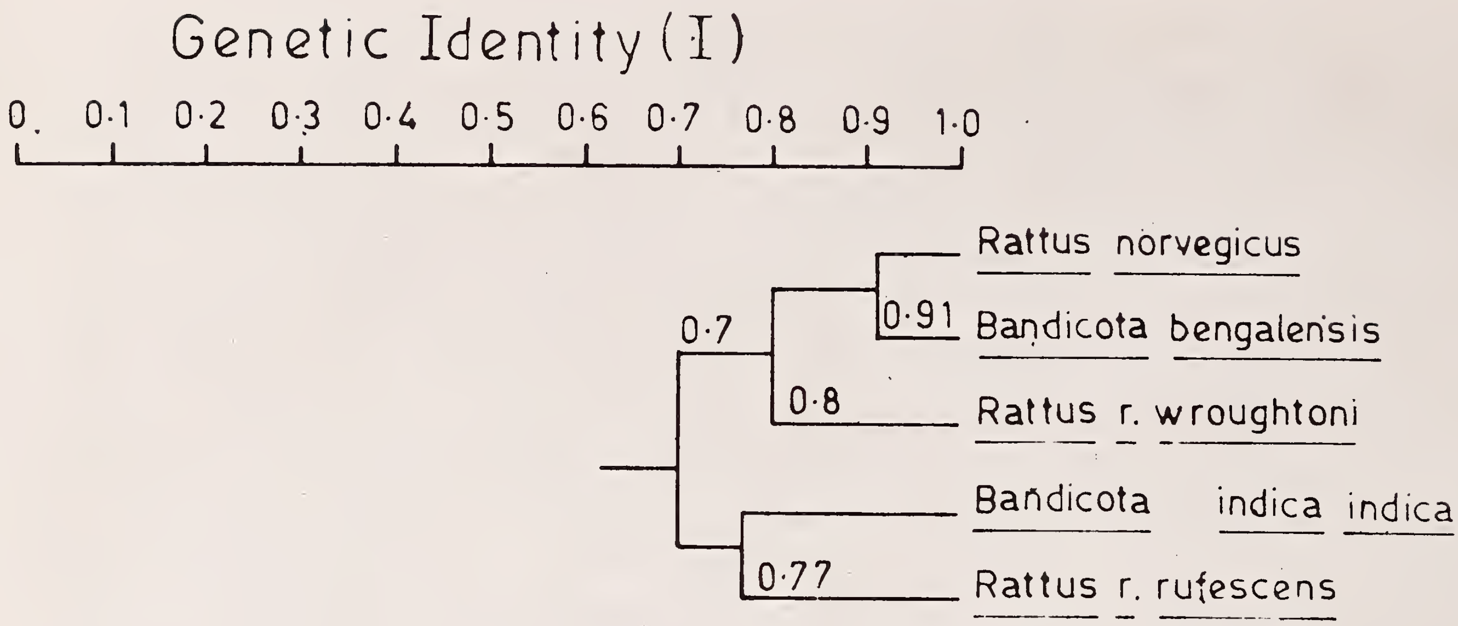

Fig. 2. Dendrogram showing relationships between species generated by cluster analysis

these values of I, the unweighted pair-group method with arithmetic means (UPGMA) of Sneath and Sokal 1973, was applied to construct a dendrogram for these five species (Fig. 2). In terms of genetic identity for haemoglobin locii, all the species studied are rather closely related (I=0.69 to 0.91). However, amongst these, *Bandicota bengalensis* and *Rattus norvegicus* are the closest (I=0.91) followed by *R. rattus wroughtoni* (I=0.8), B. *indica* (0.71) and *Rattus rattus rufescens* (I=0.69). House rat *Rattus rattus rufescens* is closer to *Bandicota indica* than any other species (I=0.77).

The genetic identities of *Bandicota bengalensis* and *Rattus norvegicus* raise certain doubts and speculations. The exotic species *Rattus norvegicus* has a striking similarity, not only in morphology but also in habit and habitats, to the indigenous *B. bengalensis*. Extensive mixing of these two genera has been reported in urban areas like Bombay, Calcutta, Madras, etc. Under these conditions a possibility that these rodents could be interbreeding cannot be ruled out. Such a possibility has already been expressed in rodents possessing white patch (Pradhan and Mithel 1981).

Comparison of *Rattus rattus rufescens* and *R. r. wroughtoni* indicates that these two subspecies of the species *Rattus rattus* have the maximum genetic distance (D=0.48, I=0.62) for the haemoglobin locii. These results when taken together with karyotypic differences reported by

TABLE 2

ESTIMATION OF GENETIC IDENTITY (BELOW DIAGONAL) AND GENETIC DISTANCES (ABOVE DIAGONAL) AMONG MEMBERS OF FIVE SPECIES OF TWO COMMENSAL RODENTS BASED ON NEI, 1972

Serial No.	Names of the species	1	2	3	4	5
1.	*Rattus rattus rufescens* (Gray)	—	0.48	0.27	0.30	0.26
2.	*Rattus rattus wroughtoni* Hinton	0.62	—	0.32	0.17	0.48
3.	*Rattus norvegicus* (Berkenhout)	0.76	0.75	—	0.2	0.29
4.	*Bandicota bengalensis kok (lordi)* (Gray)	0.74	0.84	0.91	—	0.29
5.	*Bandicota indica indica (malabarica)* (Beck.)	0.77	0.62	0.82	0.75	—

Sharma and Raman (1971) in these two subspecies, are in support of the earlier suggestion to elevate *R. rattus rufescens* to a separate species (Tiwari *et al.* 1972). Therefore we feel that, under the present circumstances, a detailed study should be undertaken to confirm the present taxonomic status of *R. rattus rufescens*.

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REFERENCES

DE SMET & WILLIAM, H.C. (1978): A comparison of the electrophoretic haemoglobin pattern of the vertebrates. *Acta zool. Pathol. Antverp. 70:* 119-131.

DOBZANSKY, T. AYALA, F.J., STEBBINS, G.L. & VALENTINE, J.W. (1976): Evolution. Freeman and Co. Reprinted by Surjeet Publ., Delhi.

ELLERMAN, J.R. (1961): Fauna of India. Mammalia. Vol. III, Part II, First Ed. Manager Publ., Z.S.I., Calcutta.

FERGUSON, A. (1980): Biochemical systematics and evolution. First ed. Blackie, Glasgow and London.

FITCH, W.M. & MORGOLIASH, E. (1970): The usefulness of amino acid and nucleotide sequences in evolutionary studies. *Evol. Biol. 4:* 67-109.

NEI, M. (1972): Genetic Distance between Populations. *Amer. Natur. 106:* 283-292.

PRADHAN, M.S. (1982): A comparison of the electrophoretic haemoglobin pattern of the commensal rodent species. *Proc. of Ind. Acad. Sci. (Anim. Sci) (Bangalore) 91(2):* 159-163.

PRADHAN, M.S. & MITHEL, M. (1981): White patch and its genetic control in some of the Indian Rodent species. *J. Bombay Nat. Hist. Soc. 78(1):* 164-165.

PRADHAN, M.S., BHAGWAT, A.M. & INGALE, S.T. (1985): Haemoglobin polymorphism in commensal species of rodents in India. *In:* Bulletin, Z.S.I. Publ. Calcutta. 7*(i)*: 103-106.

SELANDER, R.K., HUNT, W.G. & YANG, S.Y. (1969): Protein polymorphism and genetic heterozygosity in the two European subspecies of the house mouse. *Evaluation 23(3):* 379-390.

SHARMA, T. & RAMAN, RAJIV (1971): Chromosomes of a few species of rodents of Indian sub-continent. *Mamm. Chrom. Newsl. 12:* 112-115.

SNEATH, P.H.A. & SOKAL, R.R. (1973): Numerical Taxonomy. W.H. Freeman & Co., San Francisco.

TIWARI, K.K., GHOSE, R.K. & CHAKRABORTY, S. (1972); Notes on collection of small mammals from Western Ghats with remarks on the status of *Rattus rufescens* (Gray) and *Bandicota i. malabarica (Shaw). J. Bombay Nat. Hist. Soc. 68(2):* 378-384.

YOSHIDA, T.H., KATO, H., TSUCHIYA, K. & MORIWAKI, K. (1971): Karyotypes and serum transferrin patterns of hybrids between Asian and Oceanian black rats. *Rattus rattus. Chromosoma 34(1):* 40-50.

WRIGHT, C.A. (1974): Biochemical and Immunological Taxonomy of Animals. First Ed. Academic Press, London, N.Y.

ZWEIG, G. & WHITAKER, J.R. (1967): Paper Chromatography and Electrophoresis, Vol. I.A.P.; New York and London.

SIZE ANALYSIS AND SEX RATIO OF JERDON'S BULL FROG *RANA CRASSA* JERDON (ANURA: RANIDAE)[1]

S.K. Dutta, P. Mahapatra and P. Mohanty-Hejmadi[2]

(With eighteen text-figures)

A total of 324 specimens (103 females and 221 males) of Jerdon's bull frog *Rana crassa* were utilized in size and sex ratio analyses. The snout-vent length, femur length and weight of the females were 60.0 mm, 26.0 mm and 45 g (smallest) and 105.0 mm, 41.0 mm and 100 g (largest) respectively. The respective figures for males were 58.0 mm, 25.0 mm and 40 g (smallest) and 84.0 mm, 40.0 mm and 100 g (largest). Relationships between snout-vent length, femur length and weight were found to be linear. The sex ratio (male: female) was found to be 2.145:1.

Introduction

The amphibian fauna of India comprises about 201 described species, of which 55 species are included in the genus *Rana* (Inger and Dutta 1986, Chanda and Ghosh 1988, Das 1990). Of these, 3 (including *R. crassa*) are commercially valuable. The distribution of the species is localised in India (Boulenger 1920, Bhaduri 1944, Daniel 1975, Dutta and Mohanty-Hejmadi 1976, Chopra and Kumar 1977). *Rana crassa* is distributed extralimitally in Sri Lanka (Kirtisinghe 1957). Little is known on the morphometrics and sex ratio of the Indian amphibians, especially the edible species. A recent study by Mohanty-Hejmadi and Dutta (1981) is on the sex ratio and size correlation of *R. tigerina* from eastern India. Abdulali (1986) studied the sex ratio of *R. tigerina* from western India. However, no such data is available on *R. crassa*, which is found in sympatry with *R. tigerina* in Orissa.

Material and Methods

Specimens were collected from several localities in Orissa during different months of the year between 1976-1981 and 1986-1987. A total of 324 specimens (103 females and 221 males) have been utilized in this study. The snout-vent length (SVL) and the femur length of 163 *R. crassa* were measured. Data on weight of 111 males and 52 females obtained were used. For some years, data on weight was not available (Tables 1, 2). Sexing was done by examining the sexual dimorphism and examination of gonads. All morphometric variables were compared with each other by plotting graphs. Statistical analysis such as correlation coefficient (r), regression coefficient (mm), regression equation ($Y = mx + c$) were done.

Results

Size analysis of females: The total number of gravid females collected from 1978 to 1981 and during 1986 was 103. Of these specimens, the SVL and femur length of the smallest gravid female were 60.0 and 26.0 mm respectively. However, the lowest weight of a female frog was 45 g (SVL 64.0 mm). The SVL and femur length of the largest gravid female were 105.0 and 41.0 mm respectively and the maximum weight of a gravid female was 100 g. Cumulative data indicates that the highest and lowest mean of SVL and femur length were 76.8 ± 2.167, 33.75 ± 3.429 mm and 92.833 ± 7.733, 36.0 ± 3.316 mm respectively. The cumulative data on weight suggest the maximum and minimum mean weight to be 82.777 ± 9.428 and 73.5 ± 12.216 g respectively (Table 1). The

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TABLE 1

SNOUT VENT (S-V) LENGTH, FEMUR LENGTH AND WEIGHT OF *R. crassa* FEMALES IN DIFFERENT YEARS

Year of Collections	No. of individuals	(S-V) length (mm)		Femur length (mm)		Weight (g)	
		Range	Mean ± S.D.	Range	Mean ± S.D.	Range	Mean ± S.D.
1978	6	85-105	92.833 ±7.33	32-41	36	—	—
1979	18	73-91	80.055± 4.721	29-40	34.666± 4.432	70-100	82.777± 9.428
1980	24	60-89	77.916± 6.613	26-39	33.75 ± 3.429	55-95	78.333±11.389
1981	5	75-80	76.8 ± 2.167	33-38	35.6 ± 2.073	75-85	80 ± 3.538
1986	50	64-88	76.82 ± 6.454			45-100	73.5 ±12.216

Weight data for 1978 not available.

TABLE 2

SNOUT-VENT (S-V) LENGTH, FEMUR LENGTH AND WEIGHT OF *R. crassa* MALES IN DIFFERENT YEARS

Year of Collection	No. of individuals	(S-V) length (mm)		Femur length (mm)		Weight (g)	
		Range	Mean ± S.D.	Range	Mean ± S.D.	Range	Mean ± S.D.
1976	6	74—84	78.833 ± 4.622	33—39	37.333 ± 2.16	—	—
1977	2	75—83	79 ± 5.565	26—30	28 ± 2.828	—	—
1978	17	62—80	71.941 ± 4.007	26—37	30.235 ± 3.345	—	—
1979	31	60—82	67.387 ± 5.902	25—40	28.677 ± 3.448	45—90	55.483 ± 10.275
1980	42	60—82	67.0 ± 5.552	25—38	28.023 ± 2.797	40—100	53.333 ± 12.428
1981	13	60—70	63.923 ± 3.303	26—30	27.384 ± 1.386	45—75	51.538 ± 7.741
1986	110	58—74	64.284 ± 4.072	—	—	40—75	47.629 ± 8.258

Weight data for 1976-78 not available.

relationship between SVL, femur length and weight of all the female frogs of different years are shown in Figs. 5-7, 11-13 and 18.

During 1979, a total of 18 specimens were collected. These showed positive correlations between SVL and femur length (r = 0.754, linear, Y = 0.707x–21.932) (Fig. 5), between SVL and weight (r = 0.762, Y = 1.522x–39.066) (Fig. 6), and between femur length and weight (r = 0.271, Y = 0.994x + 47.541) (Fig. 7). During 1980, a total of 24 individuals were collected. Linear relationships were seen between SVL and femur length (r = 0.777, Y = 0.465x–2.48) (Fig. 11), between SVL and weight (r = 0.854, Y = 1.388x–29.814) and between femur length and weight (r = 0.779, Y = 2.878x–18.799) (Figs. 12, 13). During 1981, only 5 specimens were collected. Due to lack of data on SVL, only relationship between femur length and weight was examined, and found to be linear (r = 0.682, Y = 1.162x + 38.605). During 1986, a total of 50 specimens were collected and the relationship between SVL and weight was linear (r = 0.692, Y = 1.311x–27.211) (Fig. 18).

Size analysis of males: From 1976 to 1981 and during 1986, a total of 221 mature male *R. crassa* were collected. The lowest SVL, femur length and weight recorded were 58.0 mm, 25.0 mm and 40 g respectively. The highest SVL, femur length and weight recorded were 84.0 mm, 40.0 mm and 100 g respectively (Table 2).

As only six and two specimens were collected between 1976-1977, no correlation was made for any of the parameters used in the study. However, from 1978 to 1981, and during 1986, the number of specimens collected were 17, 31, 42, 13 and 110 respectively and the correlation between SVL with femur length, SVL

TABLE 3

SEX RATIO OF *Rana crassa*

Year of collection	Total No. collected	No. of males	No. of females	Sex ration (Male : Female)	
1976	6	6	—		—
1977	2	2	—		—
1978	23	17	6	17 : 6	(2.83 : 1)
1979	49	31	18	31 : 18	(1.722 : 1)
1980	66	42	24	42 : 24	(1.75 : 1)
1981	18	13	5	13 : 5	(2.6 : 1)
1986	160	110	50	110 : 50	(2.2 : 1)
Cumulative :	324	221	103		(2.145 : 1)

with weight and femur length with weight for each year was found to be linear (Figs. 1-4, 8-10 and 14-17).

Sex ratio: During 1976 and 1977, only 8 males were collected and thus it was not possible to obtain sex ratios for these years. Sex ratios (male: female) among specimens collected in 1978, 1979, 1980, 1981 and 1986 varied from a minimum of 1.722:1 in 1979 (49 specimens: 31 males, 18 females) to a maximum of 2.83:1 in 1978 (23 specimens: 17 males, 6 females). The cumulative data for all the years indicate the sex ratio (male: female) to be 2.145:1 (Table 3).

DISCUSSION

Size variation between sexes in *R. crassa* is one of the diagnostic characteristics of sexual dimorphism. Similar kind of observation has been obtained by Mohanty-Hejmadi and Dutta (1981) for *R. tigerina*. However, *R. tigerina* is comparatively larger than *R. crassa*. Due to similarities in several external morphological characteristics, *R. crassa* was considered as a subspecies of *R. tigerina* (Boulenger 1920, Kirtisinghe 1957). For the first time, the present study provides data on the size variability between *R. crassa* and *R. tigerina*. The relationship between the different morphological measurements of *R. crassa* was found to be linear, which is comparable with that of *R. tigerina* (Mohanty-Hejmadi and Dutta 1981).

Data on sex ratio indicates that males outnumber females, as is the case for most amphibian species found in Orissa (Dutta, unpublished data). When compared with the sex ratio of *R. tigerina* (Dutta 1979, Mohanty-Hejmadi and Dutta 1981, Abdulali 1986), it is interesting to note that Dutta (1979) and Mohanty-Hejmadi and Dutta (1981) reported more males than females of *R. tigerina*, which is comparable to that in *R. crassa*. However, Abdulali (1986) reported more females than males for *R. tigerina*. This may be due to regional variation as Abdulali conducted his studies in western India.

When the data obtained by Mohanty-Hejmadi and Dutta (1981) and Abdulali (1986) on *R. tigerina* were pooled, the sex ratio (male: female) was found to be almost 1:1. However, in the present study, the sex ratio (male: female) of *R. crassa* was 2.145:1 (Table 3). Hence, one finds variations between sex ratios of the two species. It is concluded that the presence of more males of *R. crassa* in nature leads to keen competition between the males to mate with the females. Perhaps this also ensures successful breeding of this species.

ACKNOWLEDGEMENTS

One of us (P.M.) would like to thank the University Grants Commission for a Junior Research Fellowship. Partial financial support from the Department of Environment and Forests, Government of India to S.K. Dutta is gratefully acknowledged.

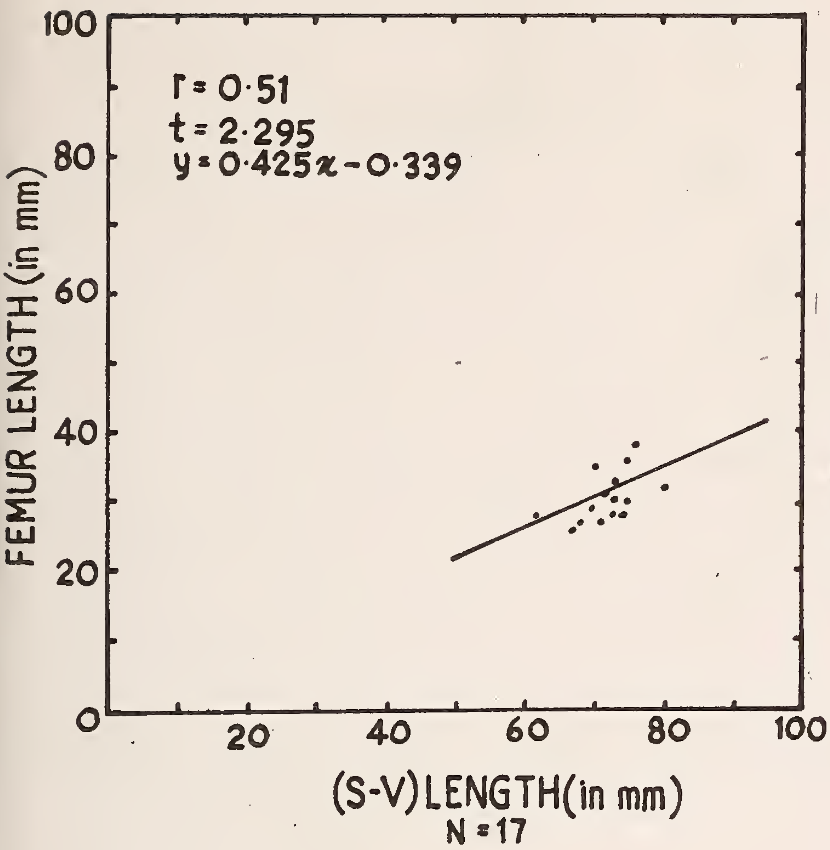

Fig. 1. Relationship between (S-V) length and femur length of male *Rana crassa* in 1978.

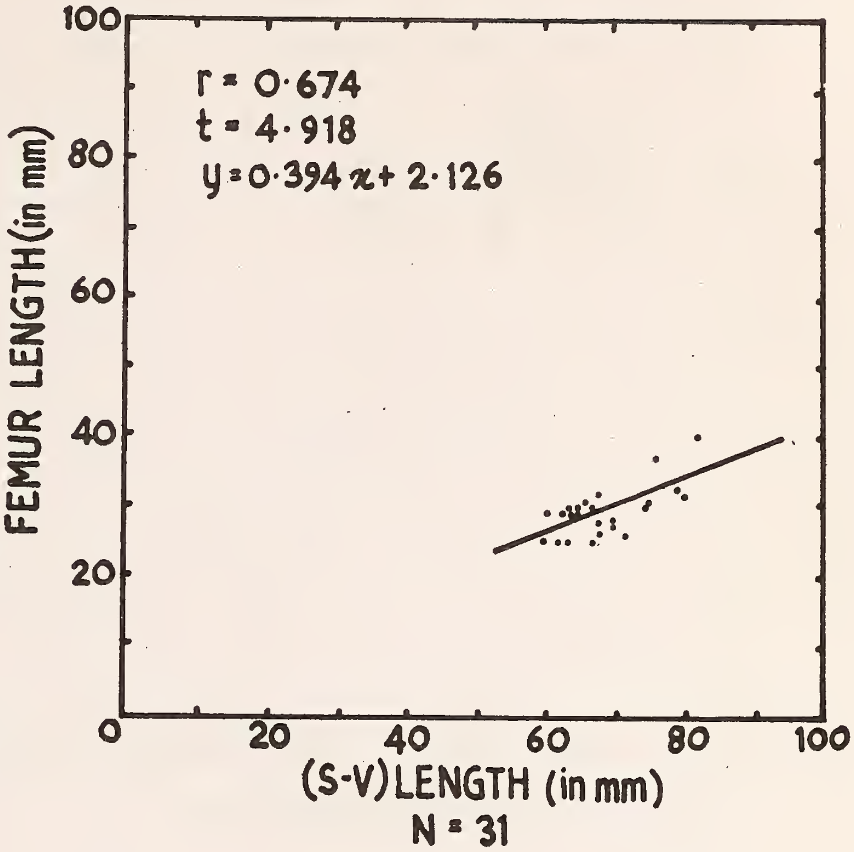

Fig. 2. Relationship between (S-V) length and femur length of male *Rana crassa* in 1979.

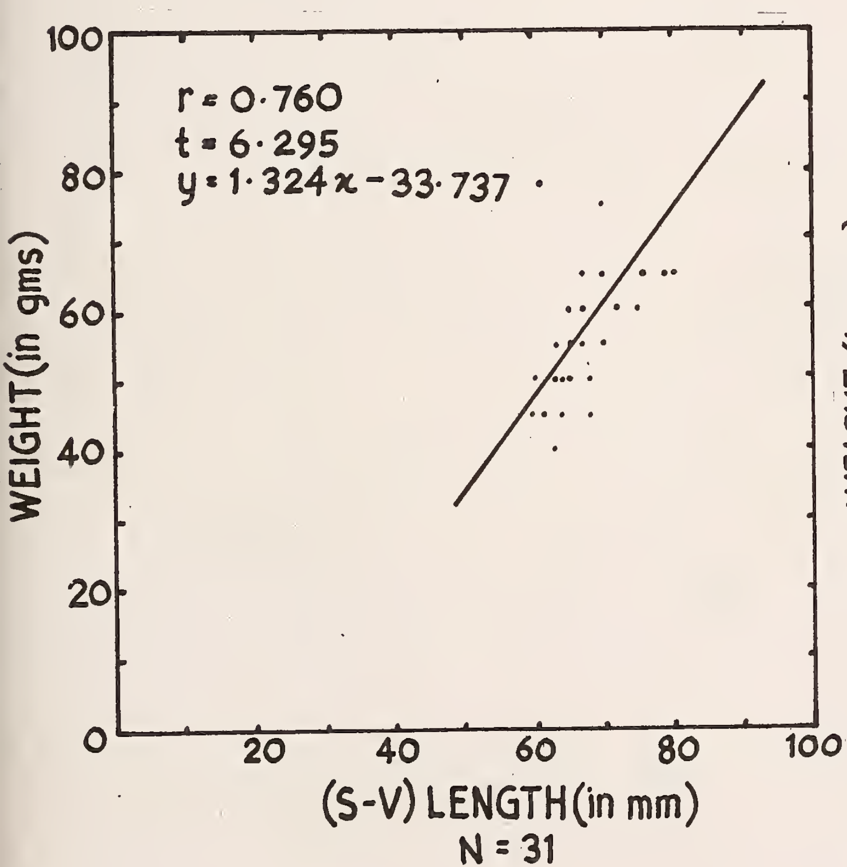

Fig. 3. Relationship between (S-V) length and weight of male *Rana crassa* in 1979.

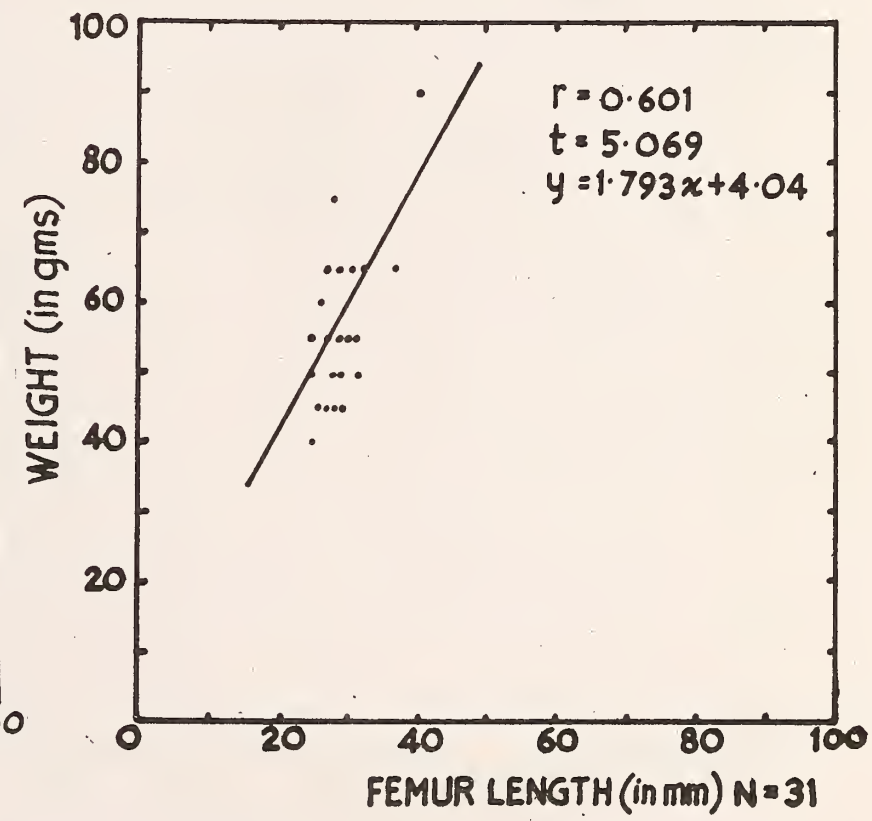

Fig. 4. Relationship between femur length and weight of male *Rana crassa* in 1979.

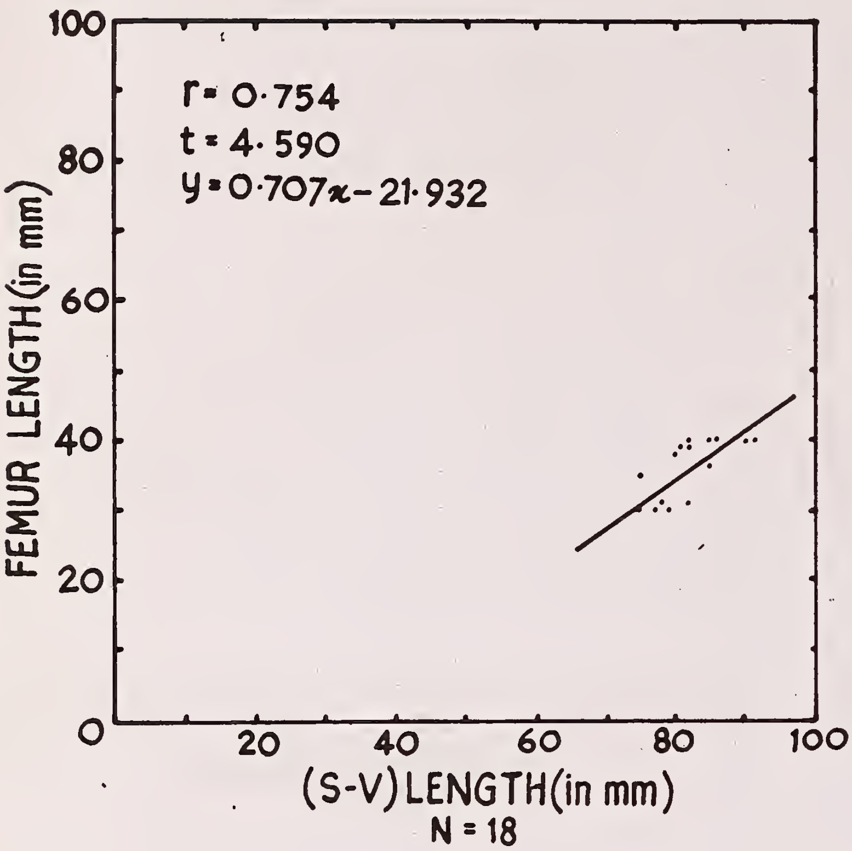

Fig. 5. Relationship between (S-V) length and femur length of male *Rana crassa* in 1979.

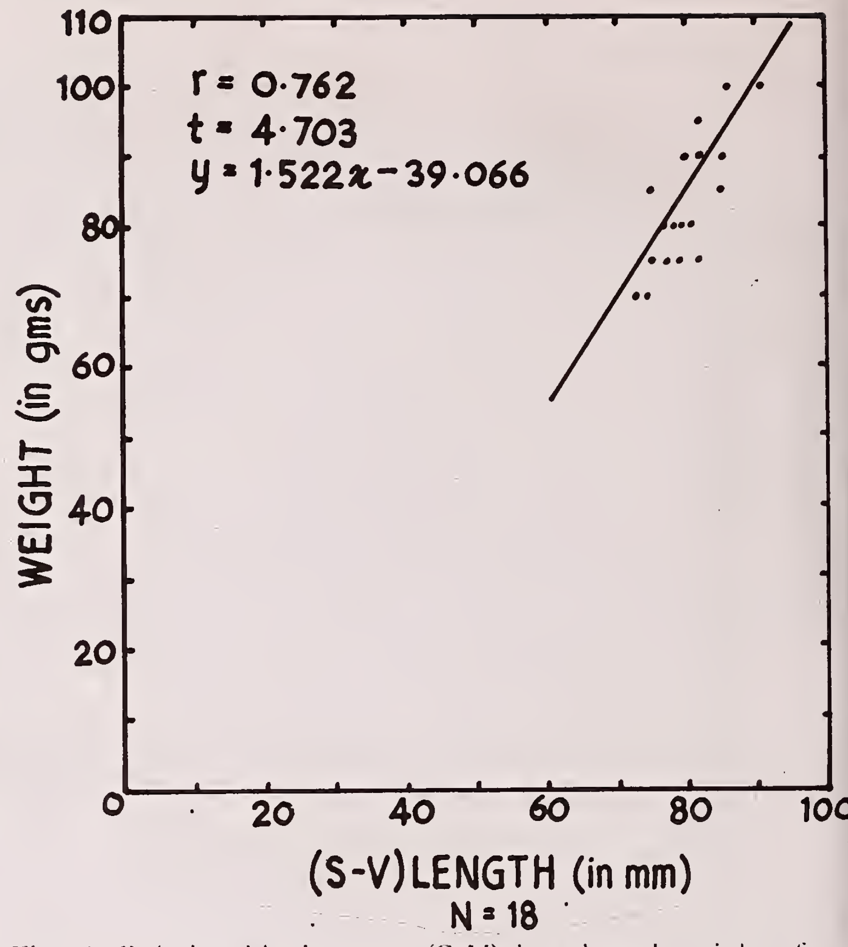

Fig. 6. Relationship between (S-V) length and weight of female *Rana crassa* in 1979.

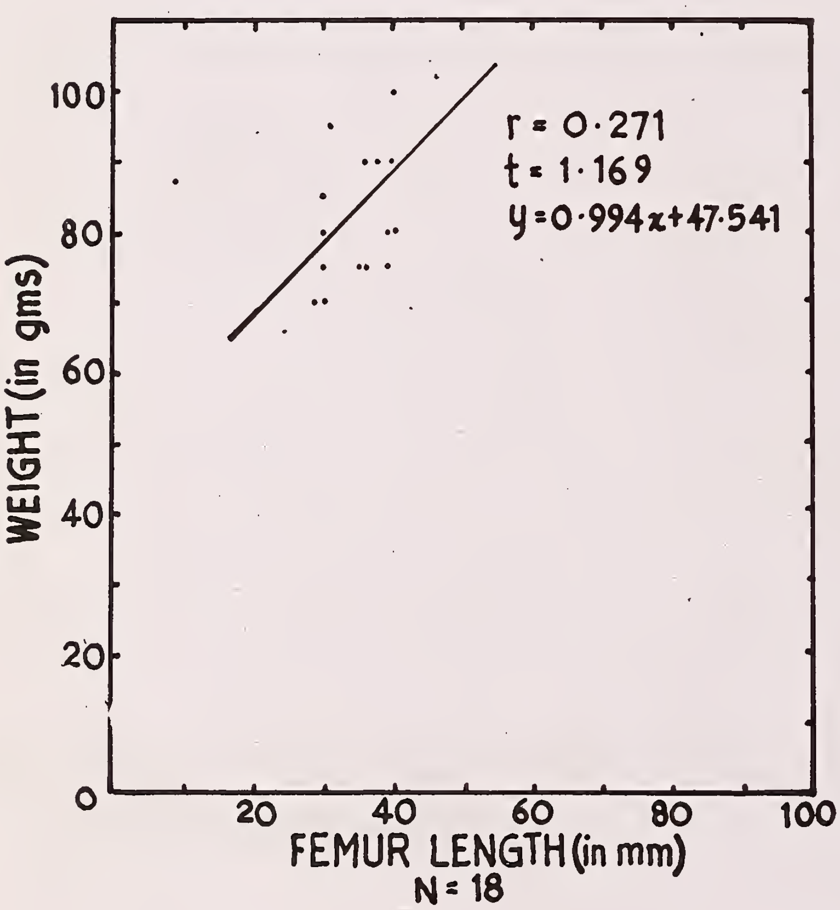

Fig. 7. Relationship between femur length and weight of female *Rana crassa* in 1979.

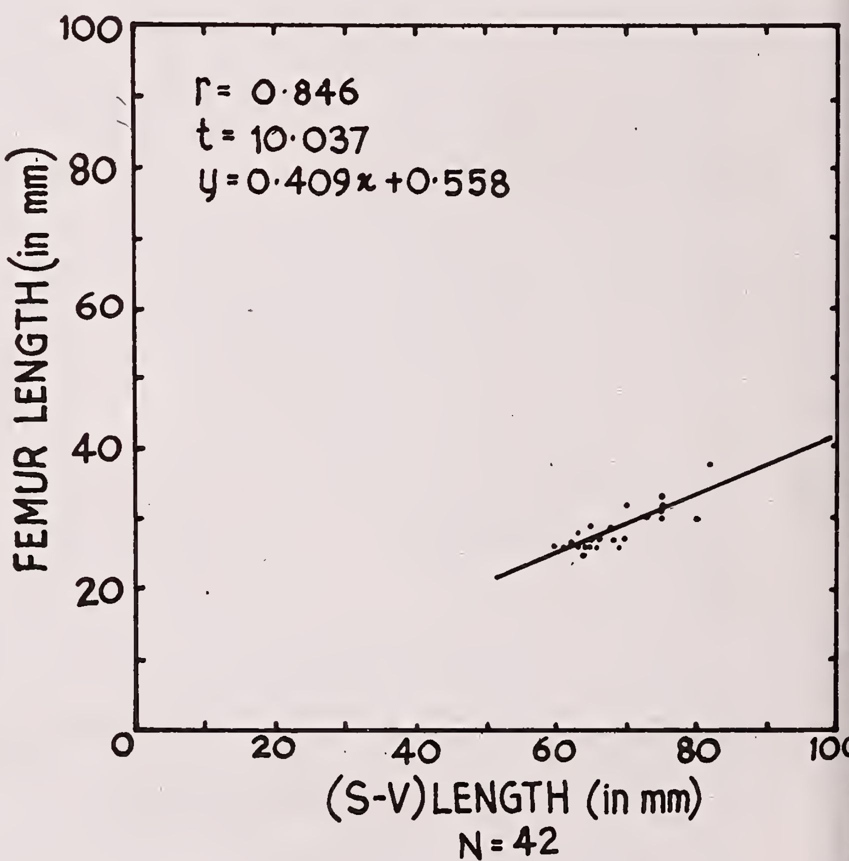

Fig. 8. Relationship between (S-V) length and femur length of male *Rana crassa* in 1980.

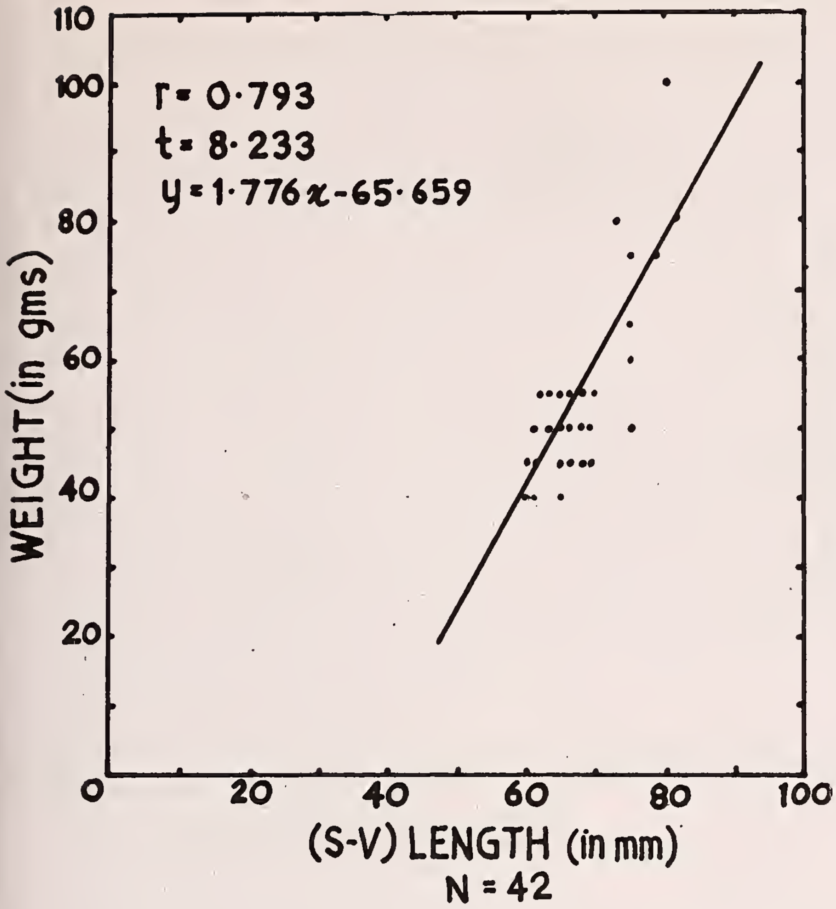

Fig. 9. Relationship between (S-V) length and weight of male *Rana crassa* in 1980.

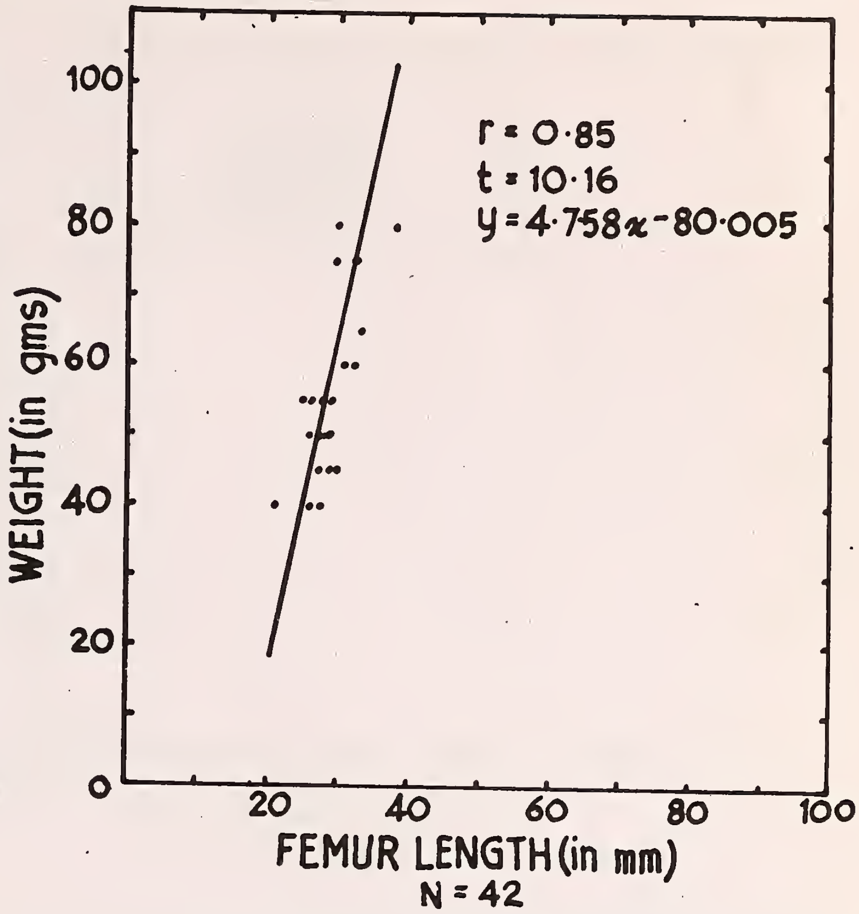

Fig. 10. Relationship between femur length and weight of male *Rana crassa* in 1980.

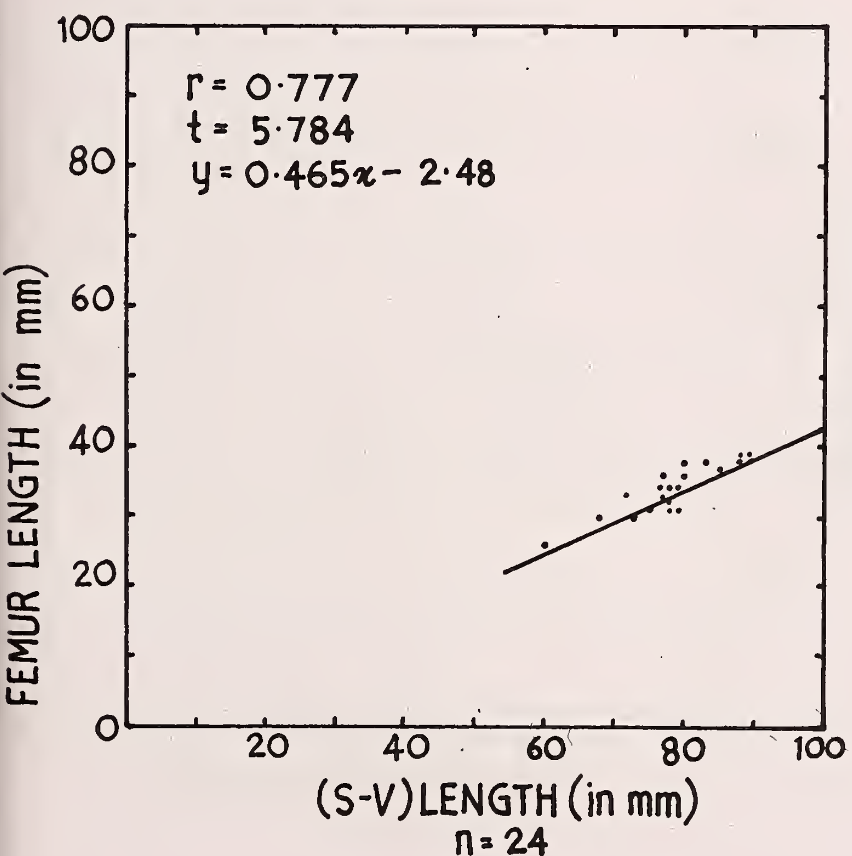

Fig. 11. Relationship between (S-V) length and femur length of female *Rana crassa* in 1980.

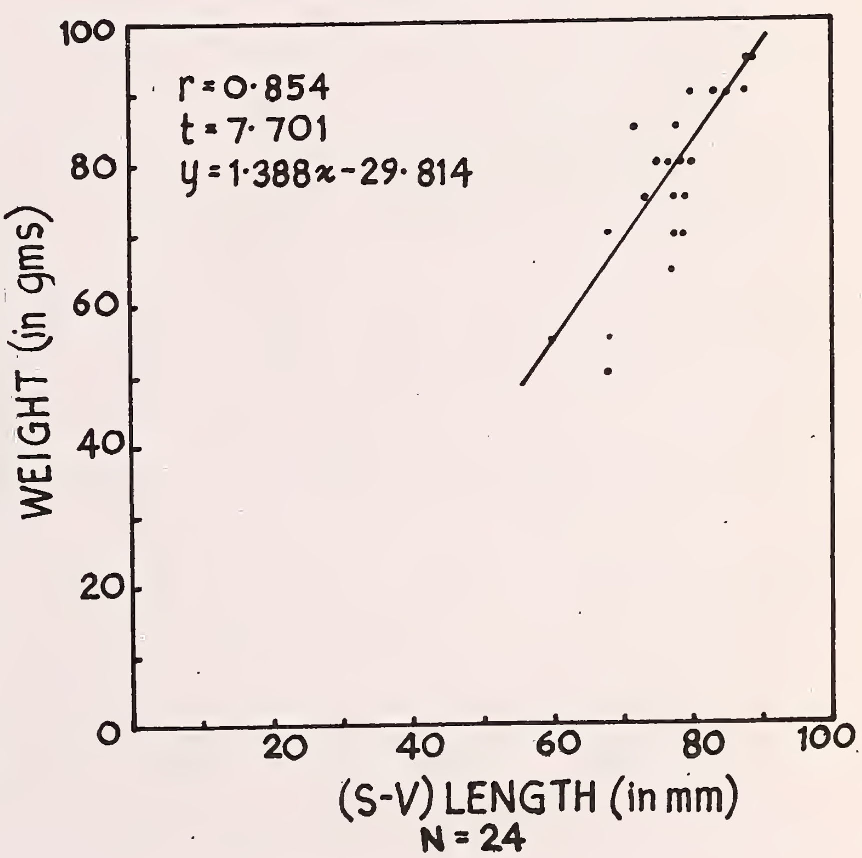

Fig. 12. Relationship between (S-V) length and weight of female *Rana crassa* in 1980.

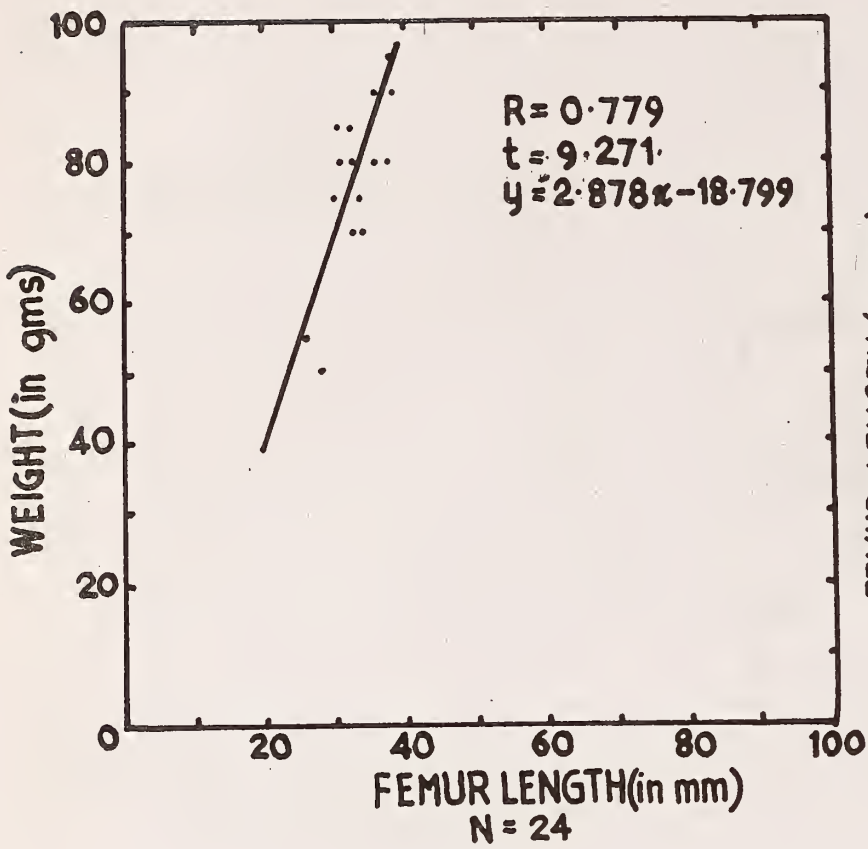

Fig. 13. Relationship between femur length and weight of female *Rana crassa* in 1980.

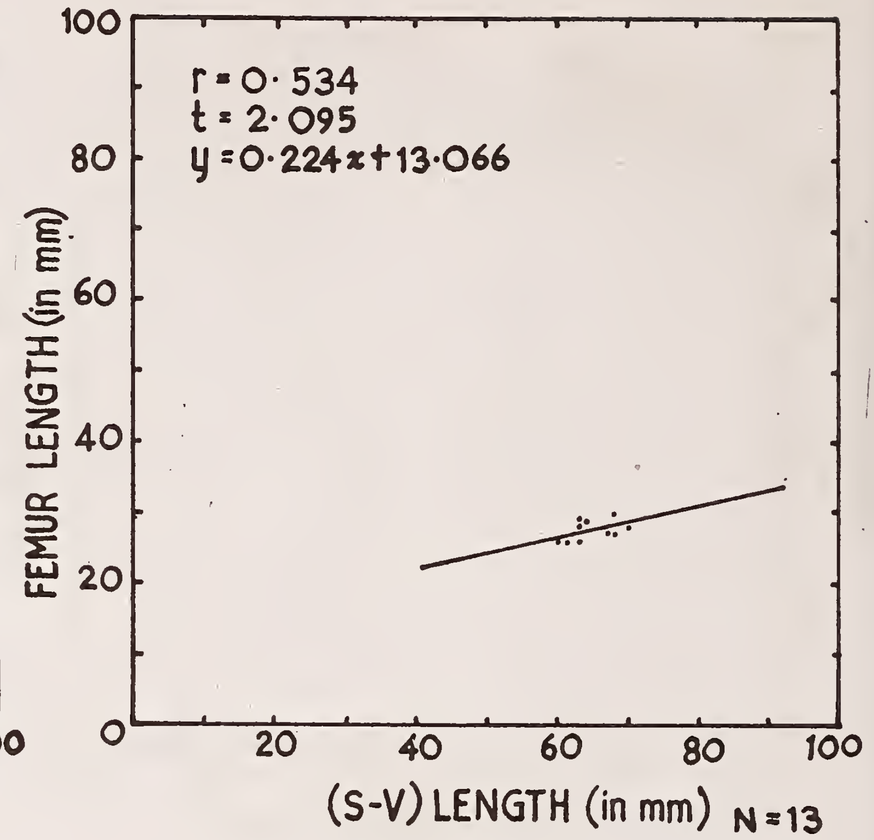

Fig. 14. Relationship between (S-V) length and femur length of male *Rana crassa* in 1981.

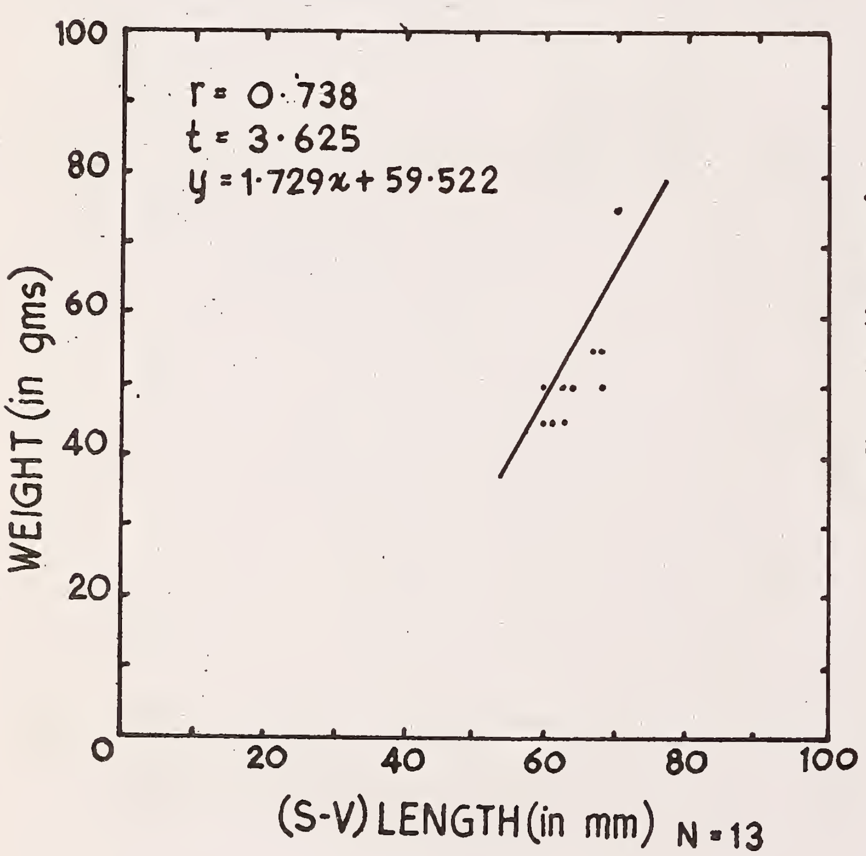

Fig. 15. Relationship between (S-V) length and weight of male *Rana crassa* in 1981.

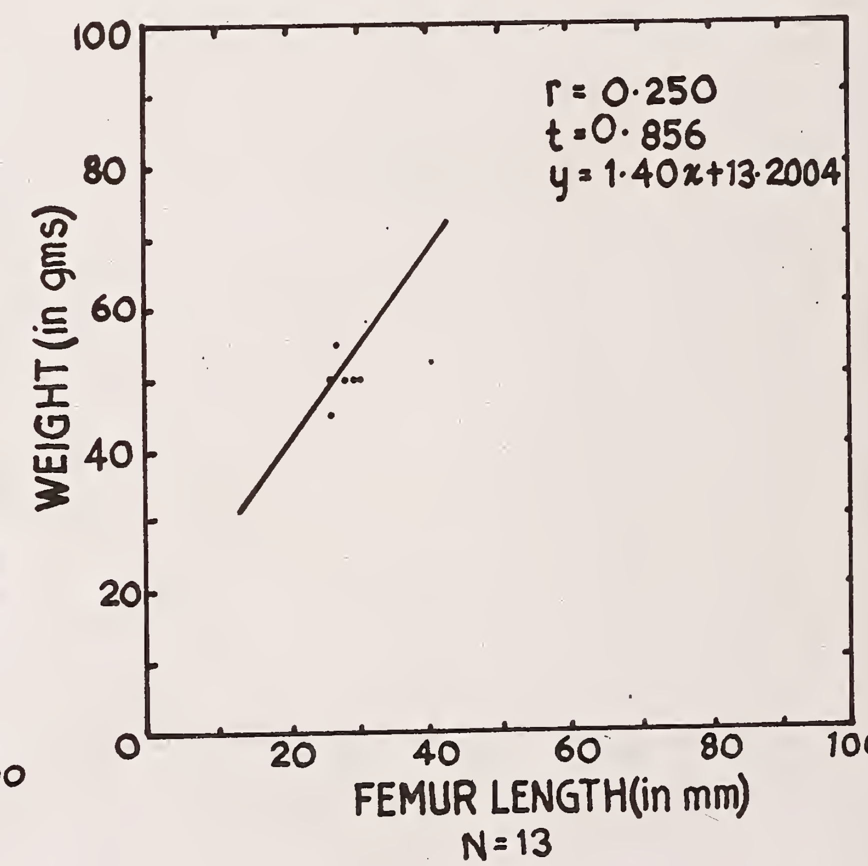

Fig. 16. Relationship between femur length and weight of male *Rana crassa* in 1981.

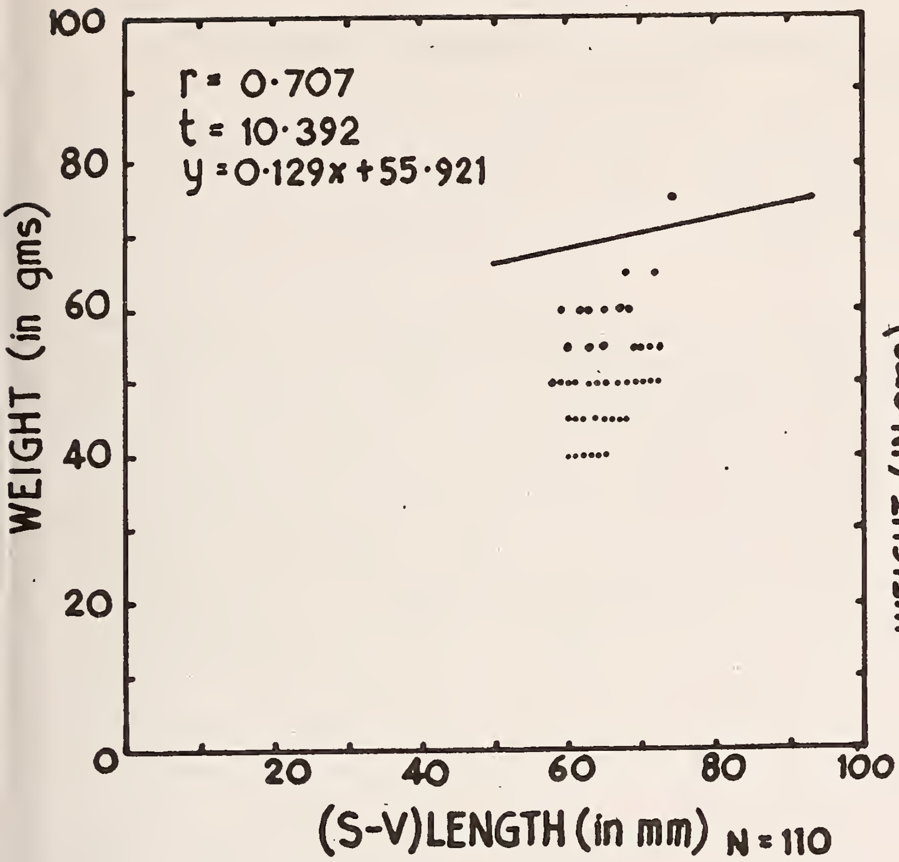

Fig. 17. Relationship between (S-V) length and weight of male *Rana crassa* in 1986.

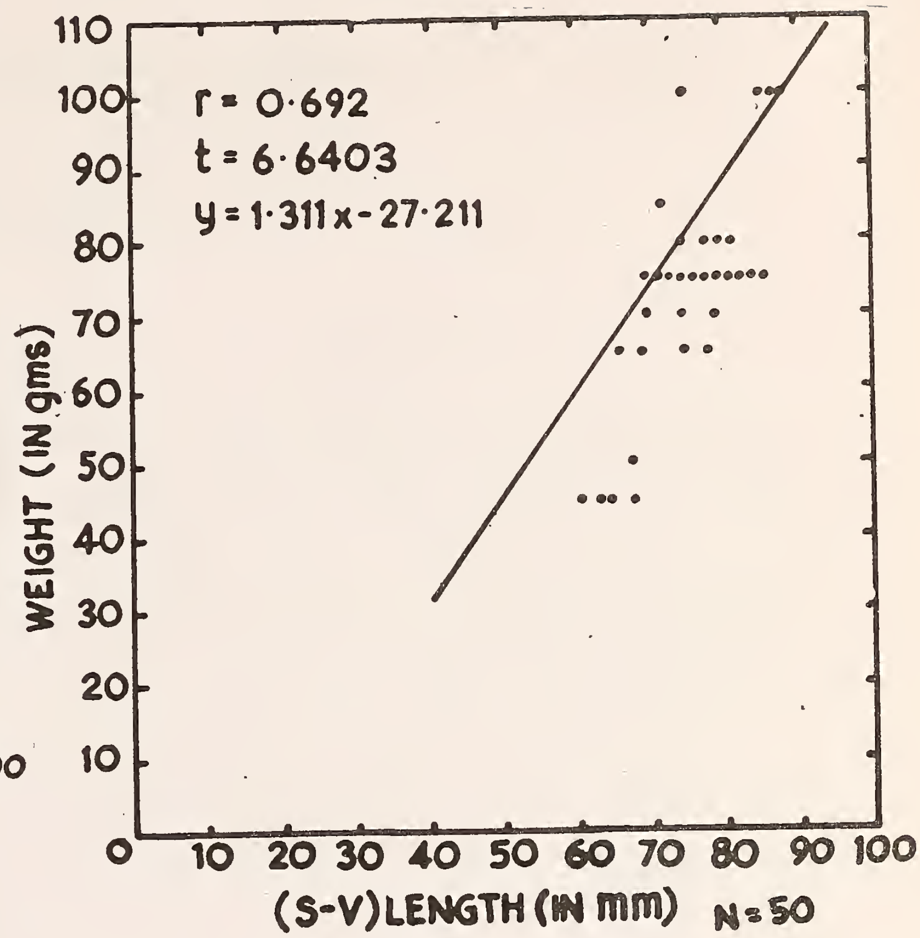

Fig. 18. Relationship between (S-V) length and weight of female *Rana crassa* in 1986.

References

Abdulali, H. (1986): On the export of froglegs from India. *Proc. First World conf. trade in Froglegs, Calcutta 2:*115-149.

Bhaduri, J.L. (1944): A note on *Rana crassa* Jerdon, with extension of its range. *J.Bombay nat. Hist. Soc. 44(3):* 481-483.

Boulenger, G.A. (1920): A monograph of the south Asian, Papuan, Melanesian and Australian frogs of the genus *Rana. Rec. Indian Mus.* 20: 17-20.

Chanda, S.K. & Ghosh, A.K. (1988): Addenda to the amphibian fauna of India. *J. Bombay nat. Hist. Soc. 85(3):* 626-627.

Chopra, R.N. & Kumar, K. (1977): Extension of range of the frog, *Rana crassa* Jerdon to Western Himalayas, U.P. ibid. *74*(1): 180.

Daniel, J.C. (1975): Field guide to the amphibians of Western India. ibid. *72*(2): 506-522.

Das, I. (1990): Amphibians from India – some further species. ibid. *87(2):* 310-312.

Dutta, S.K. (1979): Biology and the effect of chemicals and fertilizers on the eggs, developmental stages, juveniles and adults of Indian Bull frog, *Rana tigerina* (Daudin). Ph.D. Thesis, Utkal University., Orissa.

Dutta, S.K. & Mohanty-Hejmadi, P. (1976): Breeding and life history of the Indian Bull frog, *Rana tigerina* (Daudin). *Prakruti - Utkal Univ. J. Sci. 13(1-2):* 51-59.

Inger, R.F. & Dutta, S.K. (1986): An overview of the amphibian fauna of India. *J. Bombay nat. Hist. Soc. 83 (suppl.):* 135-146.

Kirtisinghe, P. (1957): The Amphibia of Ceylon. Published by the author, Colombo.

Mohanty-Hejmadi, P. & Dutta, S.K. (1981): Studies on the sex ratio and size correlation of the Indian Bull frog, *Rana tigerina* Daudin. *Pranikee – J. Zool. Soc. Orissa 2:* 26-36.

BREEDING OF EIGHT SYMPATRIC SPECIES OF *PHYLLOSCOPUS* WARBLERS IN KASHMIR[1]

TREVOR PRICE[2] AND NITIN JAMDAR[3]

(With five text-figures)

INTRODUCTION

Many ecologists have asked what affects the number of species in a community and what affects their ability to coexist. These questions are of obvious importance in the context of species preservation. Among birds, competition for food has been thought to be very important in affecting which species could coexist in a given area (Cody 1974), but in the breeding season other factors, such as nest predation (Martin 1988a, in press) and periods of sporadic food shortage outside the breeding season (Wiens 1977) and are now given a prominent role.

A basic tenet of the competition hypothesis is that ecologically identical species cannot continue to coexist. Various alternative hypotheses are therefore best examined in situations where apparently ecologically very similar species do coexist. Thus, MacArthur (1958) showed that similar species of North American warblers partitioned the foraging habitat in subtle ways during the breeding season. Lack (1971) reviewed this study, and noted that the coexistence of such similar species is extremely rare, and identified no comparable situations in Europe.

We have discovered a situation which may be similar to that studied by MacArthur (1958). Eight species of warblers in the genus *Phylloscopus* breed in the mountains surrounding the Vale of Kashmir (Ali and Ripley 1983, Price and Jamdar 1990). All species are common, and some are abundant. The species are very similar. In this paper we describe the similarities and differences among the species with respect to their breeding biology. We concentrate on adding to, and correcting previous knowledge about these birds in Kashmir, as summarised in Hume and Oates (1889), Osmaston (1927), Baker (1933), Bates and Lowther (1952), and Ali and Ripley (1983). A future paper will deal in more detail with ecological differences between the species (Price in prep.).

METHODS

This study was conducted from May through July of each year 1985- 1987 at the Overa Wildlife Sanctuary, near Pahalgam, Kashmir. A full description of the locality and methods used are given by Price and Jamdar (1990). The Sanctuary spans an altitudinal range from *c.* 2400 to *c.* 4400 m. Three distinct habitats are occupied by the warblers: the coniferous woodland, and associated deciduous trees in clearings and along valleysides (*c.* 2400 to *c.* 3100 m), the birch woodland (interspersed with conifers and rhododendrons) from *c.* 3100 to *c.* 3600 m, and juniper bushes which lie above the birch.

We spent most of our time camped at two localities named UP1 and UP2 at about 3300 m in the birch woods, but also frequently visited areas at 2400 m and 2800 m in and beside the fir woods (Price and Jamdar 1990). Much of the data we report here were collected during an intensive study of one of the *Phylloscopus* species, the yellowbrowed leaf warbler *P. inornatus* (Price and Jamdar 1991). Quality of the data varies greatly among species, and is fragmentary for the rarer species.

Many individuals were trapped in mist nets, measured, and ringed. We measured wing-

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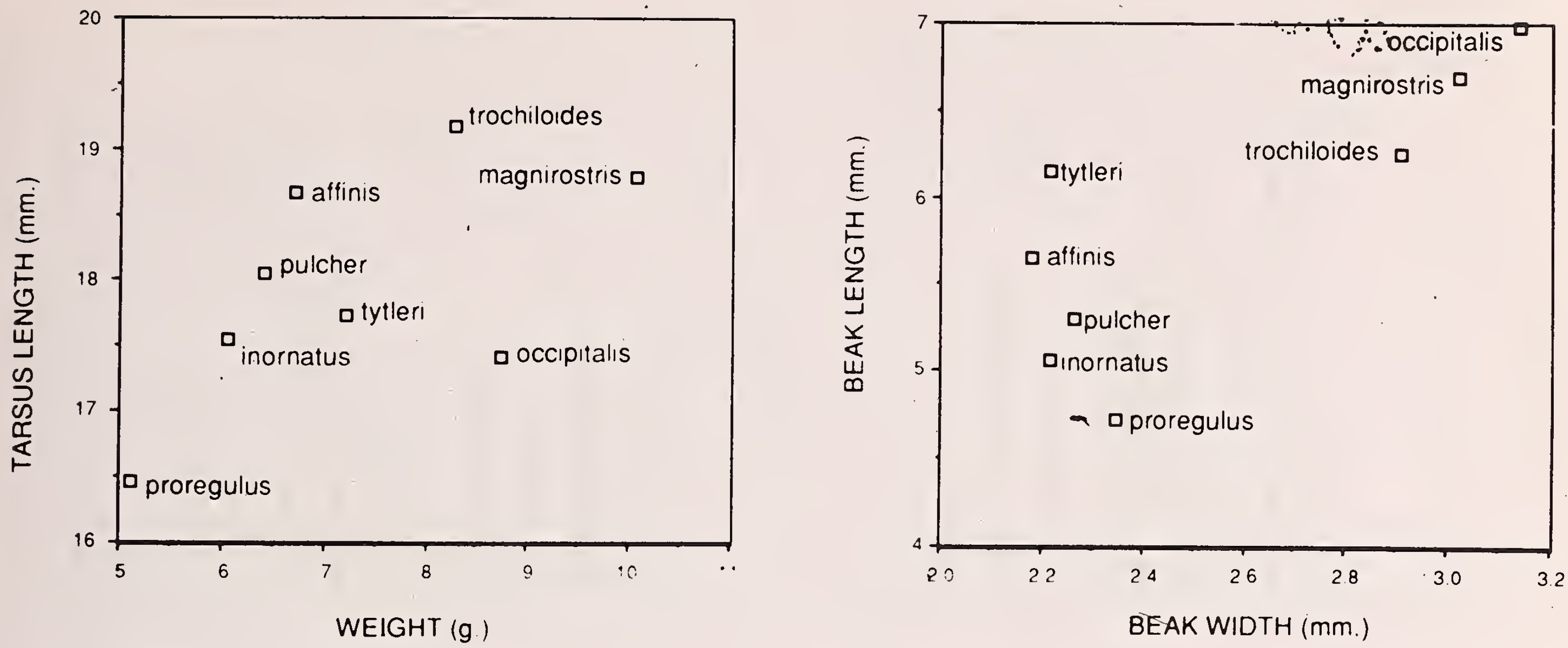

Fig. 1. Scatter plots of tarsus length against body weight, and beak length against beak width for the 8 species. Measurements from Table 1.

length to the nearest mm using the maximum chord method described by Svensson (1984) and weight to the nearest 0.1 g using a spring balance. Beak width and beak depth were measured to the nearest 0.1 mm in the plane of the anterior end of the nares using callipers. Beak depth was measured with the callipers held perpendicular to the commisure. Beak length (to the nearest 0.1 mm) was measured from the front of the nares to the tip of the bill using a pair of dividers. Although in all species the sexes look similar we were able to sex some birds. First we caught singing males by playing back tape-recorded songs. Second, only females incubate in all the species, and hence they can be sexed by the presence of a brood patch. This meant that when we trapped parents at their nest both the female and male could be sexed.

We observed birds in the field, and recorded breeding behaviours whenever possible. At intervals particularly in 1985 and 1986, we conducted a 2 km post-dawn walk along a valley in coniferous forest at *c.* 2500 m altitude, and recorded all warblers we heard singing. Whenever possible we searched for nests of all species, and recorded nest locations and contents and timing of breeding.

TABLE 1
EXTENT OF TERRITORY OVERLAP AMONG SPECIES

	tytleri	*affinis*	*pulcher*	*inornatus*	*proregulus*	*magnirostris*	*trochiloides*	*occipitalis*
tytleri								
affinis	N							
pulcher	N	N						
inornatus	O	A	O					
proregulus	P	N	A	P				
magnirostris	P	N	N	P	A			
trochiloides	N	A	O	O	N	A		
occipitalis	P	A	P	O	O	O	N	

O–Total overlap recorded: one species' territory has been recorded completely contained within the other's. P–Partial overlap recorded: one species' territory has been recorded overlapping part of the other's. A–No clear cases of territory overlap, but territories have been recorded abutting one another. N–Cases of adjacent or overlapping territories never recorded.

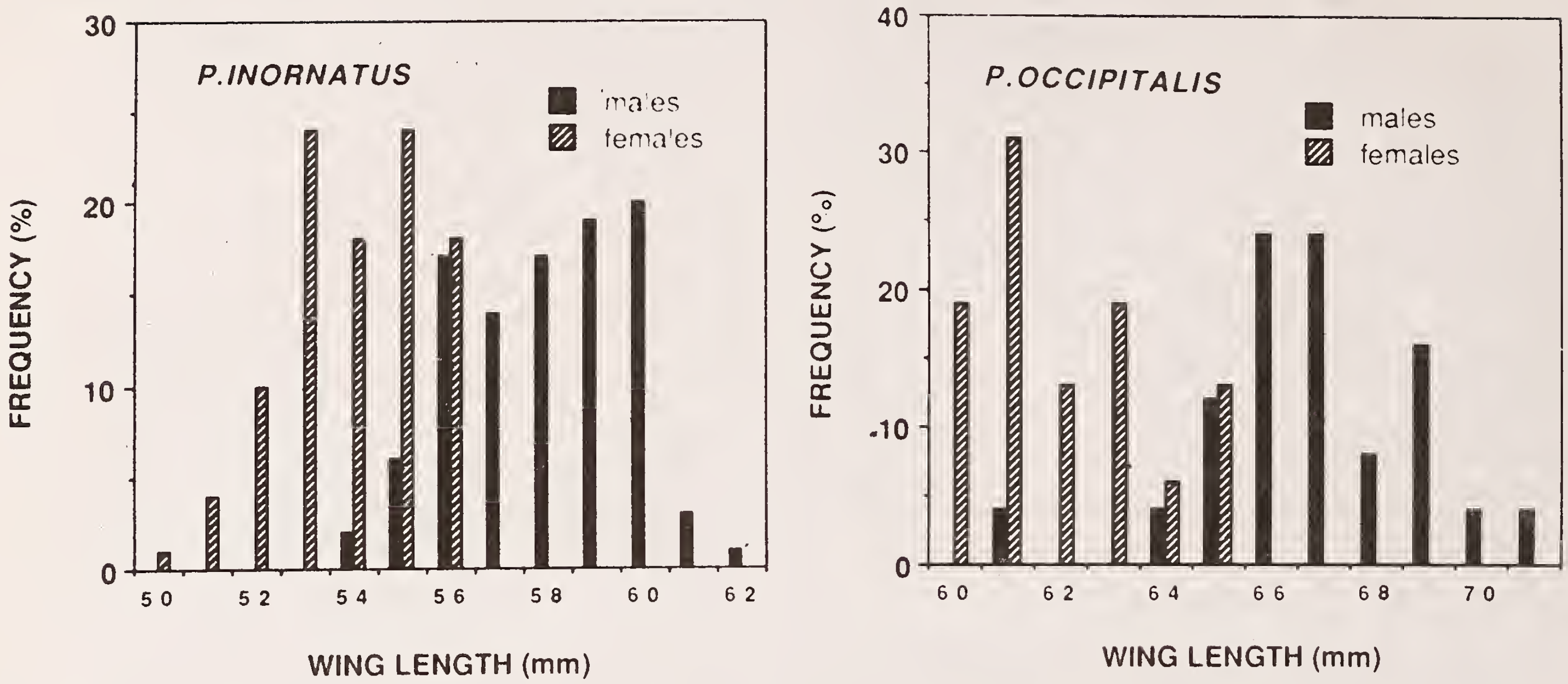

Fig. 2. Frequency histograms for wing length by sex.
Left: *P. inornatus* (N=64 males, 67 females). Right: *P. occipitalis* (N=25 males, 16 females).

TABLE 2

MORPHOMETRICS OF THE EIGHT SPECIES OF *Phylloscopus* WARBLERS STUDIED

	Wing length (mm)	Weight (g)	Tarsus (mm)	Beak length (mm)	Beak depth (mm)	Beak width (mm)	
Species	Mean ± S.D. (Min.,Max.)	Mean ± S.D. (Min.,Max.)	Mean ± S.D. (Min.,Max.)	Mean ± S.D. (Min.,Max.)	Mean ± S.D. (Min.,Max.)	Mean ± S.D (Min.,max.)	Sample size
P. tytleri	56.5± 2.2	7.2± 0.4	17.7± 0.6	6.2± 0.4	2.1± 0.2	2.2± 0.2	30
	(53.0,61.0)	(6.3,7.8)	(16.1,19.0)	(5.0,6.8)	(1.9,2.5)	(2.0,2.6)	
P. affinis/	56.2± 1.9	6.7± 0.6	18.7± 0.8	5.7± 0.3	1.9± 0.05	2.2± 0.1	5
	(53.0,58.0)	(5.8,7.4)	(18.2,20.0)	(5.4,6.2)	(1.9,2.0)	(2.0,2.4)	
P. pulcher	55.5± 2.6	6.4± 0.4	18.1 ± 0.8	5.3 ± 0.3	1.9 ± 0.1	2.3 ± 0.1	8
	(52.0,60.0)	(5.9,7.3)	(17.0,19.2)	(5.1,5.8)	(1.7,2.0)	(2.1,2.5)	
P. inornatus	55.9± 2.5	6.0± 0.4	17.5± 0.6	5.1± 0.2	1.9± 0.1	2.2± 0.1	228
	(50.0,62.0)	(5.2,8.8)	(15.9,19.1)	(4.3,6.0)	(1.7,2.3)	(1.8,2.7)	
P. proregulus	51.2± 2.6	5.1± 0.5	16.5± 0.6	4.7± 0.3	1.9± 0.1	2.4± 0.2	140
	(47.0,60.0)	(4.2,8.5)	(14.7,17.6)	(4.1,6.9)	(1.7,2.1)	(1.9,2.8)	
P. magnirostris	67.8± 3.3	10.0± 1.2	18.7± 0.5	6.7± 0.6	2.8± 0.2	3.0± 0.2	8
	(62.0,71.0)	(7.4,11.1)	(18.1, 19.5)	(5.8,7.8)	(2.4,3.0)	(2.6,3.2)	
P. trochiloides	62.5± 3.2	8.3± 0.7	19.1± 0.7	6.3± 0.3	2.5± 0.1	2.9± 0.2	15
	(57.0,67.0)	(7.4, 9.7)	(17.7,20.2)	(5.9,7.1)	(2.3,2.8)	(2.6,3.4)	
P. occipitalis	64.6± 3.0	8.7± 0.6	17.4± 0.6	7.0± 0.4	2.8± 0.1	3.1±0.2	99
	(59.0,71.0)	(7.3,11.2)	(15.5,19.1)	(5.9,8.2)	(2.4,3.1)	(2.7,3.6)	

Mean, standard deviation and range (in parentheses) are given. When individuals were captured and measured more than once their measurements were first averaged. The three beak measurements were taken from, or at, the front of the nares. The sample size varied somewhat among measurements and the smallest sample size is given.

Results

Description of the Species

Abundance and distributions: The *Phylloscopus* warblers are extremely abundant at Overa Sanctuary (Price and Jamdar 1990). Along a small valley through the fir woods at 2400 m 35% of all the small (< 150 g weight) Passerine individuals we caught were *Phylloscopus* warblers, while in the birch woods at 3300 m 43% were *Phylloscopus* warblers (Price and Jamdar 1990). In terms of biomass the corresponding figures are 18% and 23%. Besides the abundance of individuals there is also a high species diversity. All eight species are common, and at some localities in the Sanctuary, at about 3300 m, all species can be found breeding within a few hundred metres of each other (Price and Jamdar 1989).

We describe the altitudinal ranges and habitat preferences of each species in Appendix 1. Some species breed in very similar habitat — for example *P. trochiloides* breeds in birch along the treeline, overlapping completely with territories of *P. inornatus* and *P. pulcher.* Of the 28 total possible species pairs 8 (28%) have no contact with each other, while 7 (25%) have some territories which completely overlap. The remainder show partial contact (Table 1).

External appearance: The species are all very similar, being small, green above, and pale below. They differ externally in three ways: size and shape, plumage pattern, and song. We present biometrics of the eight species in Table 2. The largest species, *P. magnirostris,* is about twice as heavy as the smallest species, *P. proregulus,* and has a beak 40% longer (Table 2, Fig. 1). For the three species with sufficient sample sizes we present the measurements separately for each sex in Table 3. All three species are strongly sexually dimorphic in wing-length (with males 7-10% larger), as appears to be generally true in the *Phylloscopus* (Williamson 1974, Tiainen 1982), and possibly tarsus length, but not in body weight or the beak measurements. As in the European species (Tiainen 1982) it is possible to sex many individuals purely on the basis of wing length (Fig. 2). For example, in *P. inornatus* 75% of all the males and no females had wing lengths longer than 56 mm (Fig. 2).

Differences in plumage pattern arise from varying numbers of usually pale yellow patches on the upperparts (Williamson 1974). The patches are a superciliary stripe, bars on the greater and median coverts, a crown stripe, a

TABLE 3

MEASUREMENTS BY SEX FOR THREE SPECIES OF *Phylloscopus* WARBLERS.

	Wing length (mm)	Weight (g)	Tarsus (mm)	Beak length (mm)	Beak depth (mm)	Beak width (mm)	Sample size
	Mean± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D	Mean ± S.D.	Mean ± S.D.	
P. inornatus:							
Males	58.0 ± 1.8**	6.0 ± 0.3	17.8 ± 0.6**	5.1 ± 0.2	1.9 ± 0.1*	2.2 ± 0.1	69
Females	53.9 ± 1.5	6.1 ± 0.3	17.2 ± 0.5	5.1 ± 0.2	1.9 ± 0.1	2.2 ± 0.2	66
P. trochiloides:							
Males	64.8 ± 2.0**	8.5 ± 0.6	19.7 ± 0.3	6.5 ± 0.5	2.5 ± 0.2	3.0 ± 0.3	4
Females	58.3 ± 1.0	7.8 ± 0.3	18.7 ± 1.1	6.1 ± 0.1	2.5 ± 0.1	3.0 ± 0.1	4
P. occipitalis:							
Males	66.9 ± 2.0**	8.6 ± 0.5	17.4 ± 0.6	7.1 ± 0.4	2.8 ± 0.2	3.1 ± 0.2	27
Females	62.3 ± 1.8	9.0 ± 0.8	17.6 ± 0.7	7.1 ± 0.5	2.7 ± 0.1	3.2 ± 0.2	18

Means, standard deviations and sample sizes are given. Only species for which at least four individuals of each sex were measured are included. Significance of the sex difference was assessed using *t* tests.**P<0.001 *P<0.05. All other differences were not significant.

TABLE 4

COMPOSITION OF NESTS

	Weight(g)	Grass	Lichen	Moss	Birch bark	Feathers	Hair	Sample size
P. tytleri	7	*	*	-	*	*	*	1
P. pulcher	19	*	-	*	*	*	*	1
P. inornatus [1]	17(12,25)	*	?	79	72	-	96	33
P. proregulus	10,12	*	*	-	*	*	-	2
P. occipitalis	14,15,23	66	-	*	33	–	66	3

[1]For *P. inornatus* the figures in parentheses after weight give the minimum and maximum weights recorded. *indicates every nest contained at least some of this material. The numbers indicate precentages of nests with a particular constituent. For all species the dominant constituent of the nest was grass, except for *P. occipitalis*, where it was moss.

rump patch, and white in the outer tail feathers. Two species — *P. tytleri* and *P. affinis* — have only the superciliary stripe, while one species *P. pulcher* has all the described patches. The others have intermediate numbers of patches (Williamson 1974). In *P. pulcher* the patches are distinctly orange, while *P. affinis* has bright yellow underparts.

All species sing characteristic songs. These songs have been described with sonagrams by Martens (1980). Three of the species – *P. pulcher, P. inornatus* and *P. proregulus* – sing two different songs (Martens 1980). We describe the context in which these songs are sung, and also previously undescribed call notes in a section below on the individual species. The general importance of song in speciation and mate recognition has been demonstrated in studies of European *Phylloscopus* (Thielcke *et al.* 1978, Helb *et al.* 1982).

BREEDING BIOLOGY

In this section we contrast the breeding behaviour of the eight species. In many respects they are very similar. All build domed nests. Only the female incubates, while both parents feed the young. They differ in nest placement, nest materials, time of breeding, and slightly in

TABLE 5

CHARACTERISTICS OF NEST LOCATIONS FOR THE 8 *Phylloscopus* SPECIES

	tytleri	*affinis*	*pulcher*	*inornatus*	*proregulus*	*magnirostris*	*trochiloidse*	*occipitalis*
Hedgerow	1							
Juniper		5						
Birch	2		4					
Fir	2				8			
Rhododendron			6					
Ground or ledge				349		1	8	
Under stone								20*
Hole in tree								4
Tree cavity						1		7[1]
Rock cavity						1		1
Tree roots						2		1
Building wall								13
Total	5	5	10	349	8	5	8	46

* One nest was under a piece of wood on the ground.

1This includes 2 nests built under pieces of wood on fallen trees, and 3 predominantly in earth holes.

TABLE 6

MEDIAN FLEDGE DATES FOR *Phylloscopus* SPECIES AT THE HIGH ALTITUDE SITES

	1985	1986	1987
P. tytleri	—	—	19 July (1)
P. pulcher	29 June (1)	23 July (2)	20 July (1)
P. inornatus	28 June (54)	13 July (41)	10 July (55)
P. proregulus	—	—	22 July (1)
P. magnirostris	20 July (2)	—	—
P. trochiloides	19 July (4)	27 July (3)	27 July (1)
P. occipitalis	8 July (5)	17 July (2)	20 July (3)

Median fledging date, with sample size in parentheses.

TABLE 7

DISTRIBUTIONS OF CLUTCH AND FLEDGE SIZES

	Number of eggs in clutch					Mean clutch size	Number of fledglings					Mean fledge size
	1	2	3	4	5		1	2	3	4	5	
P. tytleri					1	4.0		1				2.0
P. affinis					1	4.0						
P. pulcher			1	3		2.75		2	1			2.3
P. inornatus	5	13	46	170	19	3.73	5	16	32	54	11	3.4
P. proregulus										1		4.0
P. magnirostris							1	1	1	1		2.5
P. trochiloides		1	1	2		3.25		1	3	3		3.0
P. occipitalis			4	6	2	3.83			5	18		3.78

Shown are the number of nests containing each clutch or fledge size.

TABLE 8

MEASUREMENTS OF *P. occipitalis* AT THE LOW ALTITUDE (FRH) AND HIGH ALTITUDE (UP1) SITES

	Wing length (mm) Mean±S.D.	Weight (g) Mean± S.D.	Tarsus (mm) Mean± S.D	Beak length (mm) Mean± S.D	Beak Depth (mm) Mean± S.D.	Beak Width (mm) Mean± S.D.
FRH	65± 3.0	8.6± 0.6	17.3± 0.6	6.9± 0.3	2.8± 0.1	3.1± 0.2
UP1	65± 2.5	8.5± 0.6	17.9± 0.6**	7.1± 0.5	2.7± 0.1	3.0± 0.2

Sample sizes of birds measured are 59 at FRH and 11 at UP1. Significance between the two sites for each character was assessed by a two-tailed *t* test * $P < 0.05$ ** $P < 0.01$.

average clutch size. We have been unable to ascertain incubation and nestling periods for any species except *P. inornatus.*

Nest characteristics and nest placement: In most species the main construction material is grass, supplemented on the outer layers with moss, lichens and birch bark (Table 4). *P. occipitalis,* however, builds its nest almost entirely of moss. The lining differs among species. Of the five species whose nests we have carefully examined, three have always had feathers lining their nest, and two never have (Table 4). The difference between not using and using feathers corresponds with ground and hole nesters, which do not have feathers, but line with thin grass, mammal hair, or sometimes in the case of *P. occipitalis* do not line at all, and tree branch nesters, which use feathers, and also hair at least in some species (Table 5).

The difference may be related to the need

for greater insulation in trees (Moller 1984), but it is difficult to see what disadvantage there could be to ground nesters in using feathers. Moller (1984) suggests that the feathers make the nest more conspicuous, but this does not seem likely for species with domed nests. In addition, two species of European *Phylloscopus* studied by Tiainen *et al.* (1983) use feathers but nest on the ground. *P. pulcher* uses many feathers in its nest, and may place a feather 'door' across the nest entrance, as has been observed for *P. collybita* and *P. trochilus* in Finland (Tiainen *et al.* 1983).

Nest locations: Most species show characteristic differences in their choice of nest location (Table 5). Two species (*P. inornatus* and *P. trochiloides*) nest on the ground, and use similar sites (the nests also appear similar, except for the larger size of that of *P. trochiloides* whose nest we have not examined in detail). *P. occipitalis* uses a variety of nest sites, including holes in earth banks, rocks, buildings, and trees (where they have been recorded up to 10 m by us) and under stones and fallen pieces of wood. We have recorded *P. tytleri* nesting in birch (at 8 m), in a hedgerow (at 2 m), and in a fir tree (at 15 m). Like *P. proregulus,* the nest is built among thin branches. *P. pulcher* either builds a nest among the thin branches of a rhododendron, where it can be quite conspicuous, or in a cavity on a sturdy branch of a birch tree.

Time of breeding: Timing of breeding is examined in Table 6, using the average day on which the nestlings fledge. Use of fledging date confounds variation in incubation and nestling period with date of laying, but our observations on eggs and young of several species, while not providing exact information on the incubation and nestling periods, lead us to believe that they are similar among species.

In *P. inornatus,* which breeds early, incubation period can vary from 12-22 days (Price and Jamdar 1991); such variation is unlikely in the other species which breed later in more favourable conditions. We show in a later section that for *P. occipitalis* timing of breeding varies with altitude, hence we consider only observations at the high altitude camps (where apart from some *P. occipitalis* and one *P. magnirostris* nest all nests with fledglings were found).

Time of fledging appeared to vary among years for all species, but, given the small samples, significantly only in the case of two species; *P. inornatus:* $F(2,147)=143, P<0.0001$; *P. occipitalis:* $F(2,7)=41, P<0.001$. In 1985 all species bred earlier than in the other two years, presumably because of the better weather in that year (Price and Jamdar 1990).

In each year we found significant variation in time of breeding among the species; 1985: $F(4,59) = 25, P<0.0001$; $F(3,60) = 10, P<0.0001$; 1987: $F(5,48)=3.0, P<0.05$. *P. inornatus* bred the earliest, and *P. magnirostris* and *P. trochiloides* the latest. For several species sample sizes are small, but the timing of breeding agrees broadly with our many observations on nest building and on nests containing eggs (sample sizes in Table 5) and on post-breeding family parties. The exception is *P. pulcher,* which (based on nest building) may have on average bred earlier in 1986 than our two fledging dates indicate.

Clutch and fledge sizes: Clutch sizes for all species are presented in Table 7. For several species we have small samples, and we suspect the average clutch represented by the *P. pulcher* sample is atypically low for that species. Apart from *P. pulcher* four is the commonest clutch size for all species. Similar values for clutch sizes have been presented by Hume and Oates (1889) and Baker (1933). Clutch sizes are lower than the six or more commonly recorded for European species of *Phylloscopus* (Tiainen *et al.* 1983).

Predation: We have noted nest predation as having occurred on all species except *P. tytleri.* A list of known predators is given by Price and Jamdar (1991). We have actually observed the following predation events: nutcracker *Nucifraga caryocatactes* on *P. inornatus* and *P.*

pulcher (nests with eggs); Himalayan viper *Agkistrodon himalayanus* on *P. occipitalis* (nest with fledglings). Much predation was attributable to an unnatural abundance of crows and some of it to crows following us. Hence it is impossible to determine a natural rate of predation, or to look for differences among the species in association with their nesting habits.

Nest parasitism: Nestlings of *P. occipitalis* commonly have fly larvae, presumably of the genus *Protocalliphora* (Owen 1954) up to 1 cm long attached to their feet, and more rarely their head. We did not keep detailed records, but have noted up to five on one nestling. Infested nestlings appeared healthy, and fledged successfully. The highest altitude at which we have observed these larvae is at 2800 m at Kanj Kut and we have not found them at the high altitude sites, or on any other species.

Three species of cuckoo *(Cuculus)* are present in the study area (Price and Jamdar 1990). All have been recorded as brood parasites of *Phylloscopus* species (Ali and Ripley 1983). In fact we found a single case of brood parasitism: a *P. affinis* nest with a young small cuckoo *Cuculus poliocephalus* in it. We did not find any evidence of brood parasitism in more than 200 nests of *P. inornatus,* despite the small cuckoo being common where it breeds. This suggests that *P. inornatus* is a 'rejector species' (Brooke and Davies 1987) and will not incubate cuckoo eggs.

Observations

The purpose of this section is to present information on those species which differs from, or adds to, that in the current literature (Gaston 1974, Williamson 1974, Martens 1980, Ali and Ripley 1983).

Phylloscopus tytleri: Alexander (1950) mistook this species for *Phylloscopus neglectus,* which has not been recorded by us or any other observer in Kashmir, and Alexander's error was perpetuated by Ali and Ripley (1983). Thus the song *ti wish i* which is attributed to *P. neglectus* by Alexander is clearly the *let's kiss him* phrase aptly coined by Osmaston (1927) to describe the song of *P. tytleri* (see also the sonagrams of Martens 1980). We have never heard a song resembling the *whittle di wee you* which Alexander attributed to *P. tytleri.*

The call note of *P. tytleri* does not seem to have been recorded by previous workers: it is a plaintive *sooeet.* It is not often heard at the beginning of the breeding season, but is uttered when an observer is around the nest and is very common in July, particularly when the birds are in family parties after the young have fledged.

P. tytleri has a long and slender bill (Williamson 1974; Table 2). We suspect that this may enable it to probe flowers for insects and/or nectar and pollen. We caught several individuals with red pollen on their chins and foreheads.

***Phylloscopus affinis*:** This species breeds at higher altitudes than the others, and is *a priori* more likely to be susceptible to late inclement weather. Although in both 1986 and 1987 birds were singing on territory by mid May, we also observed a male singing at Overa village on 3 June 1986, suggesting that birds leave their territories if the weather is bad and/or some birds arrive late. We have no information on fledging date, but have observed nest building in the first two weeks of June, and found a nest with eggs on 27 June 1986. We also found one nest with a well developed small cuckoo chick in it on 13 July 1985. This implies that fledging may occur in mid-July, and that *P. affinis* does not breed much later than some of the other species (Table 6).

Phylloscopus pulcher: Each male sings two songs (Martens 1980). The first song is a hard *tick tick tick* followed by a trill and the second a musical *dioo dioo..,* for about eight repeats of the *dioo.* The songs appear to be used in different contexts. The first song is heard throughout May when the weather is fine. It is sung by males seen foraging in areas 100-200 m below their future territories (they are commonly seen down to 3300 m prior to breeding, al-

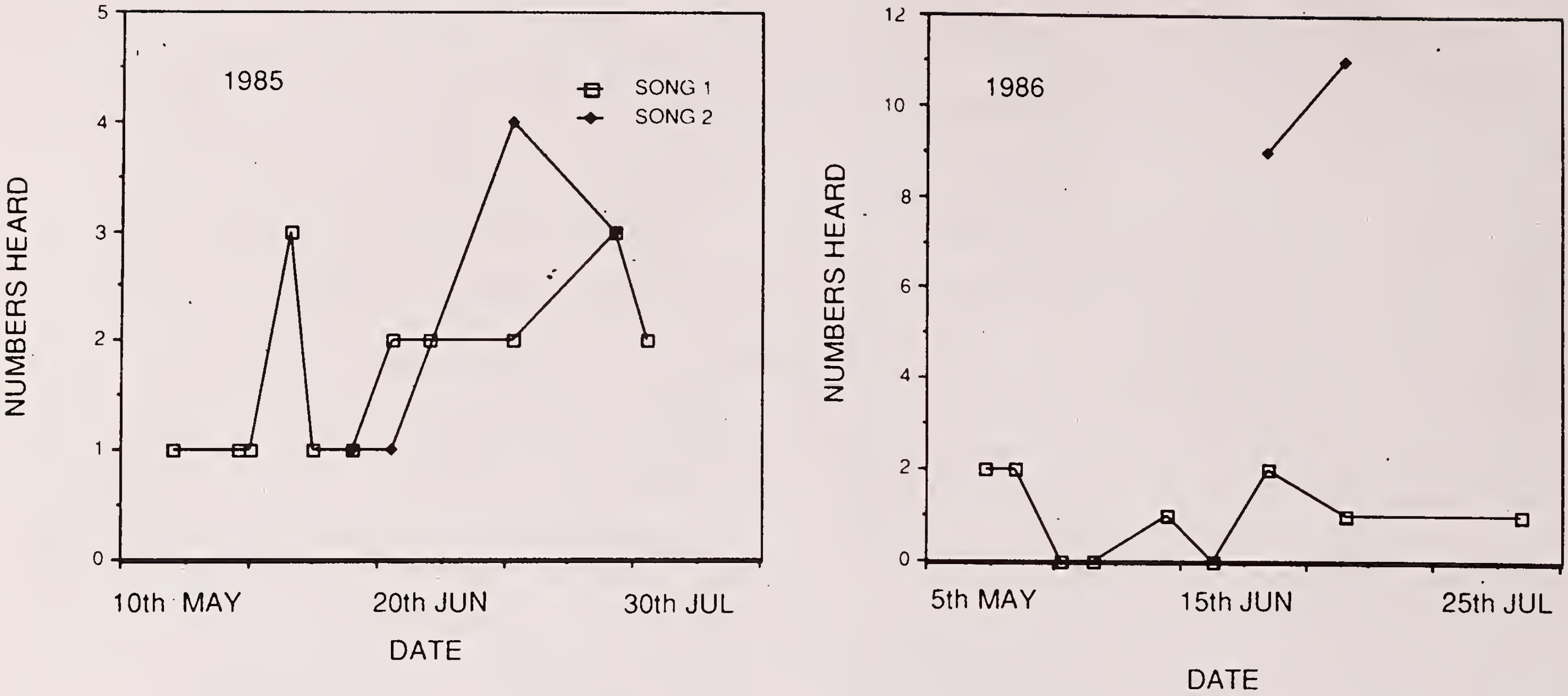

Fig. 3. The numbers of *P. proregulus* singing each of the two song types, observed on a 2 km post dawn walk along a valley through coniferous forest, conducted at irregular intervals in 1985 (left) and 1986 (right). Song 1 is the trill song, Song 2 is the long rambling song (see text).

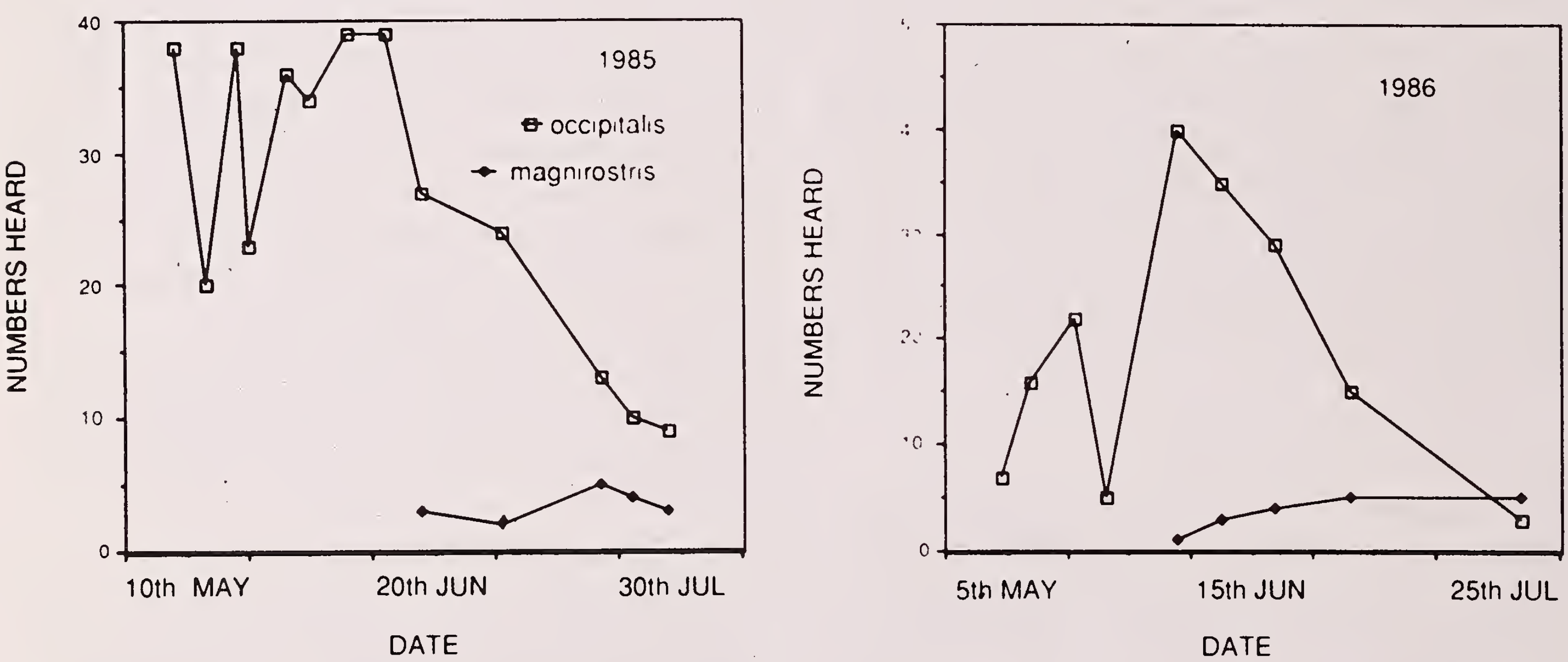

Fig. 4. The numbers of *P. occipitalis* and *P. magnirostris* singing, observed on the post dawn walk through coniferous forest.

though we have not recorded them lower). The second song is heard intermingled with the first, but it is only sung by males on territory. In 1986 it was first heard on the 11 June, and in 1987 it was first heard on 3 June.

Phylloscopus inornatus: We made a special study of this species and the results are reported in a separate paper (Price and Jamdar 1991).

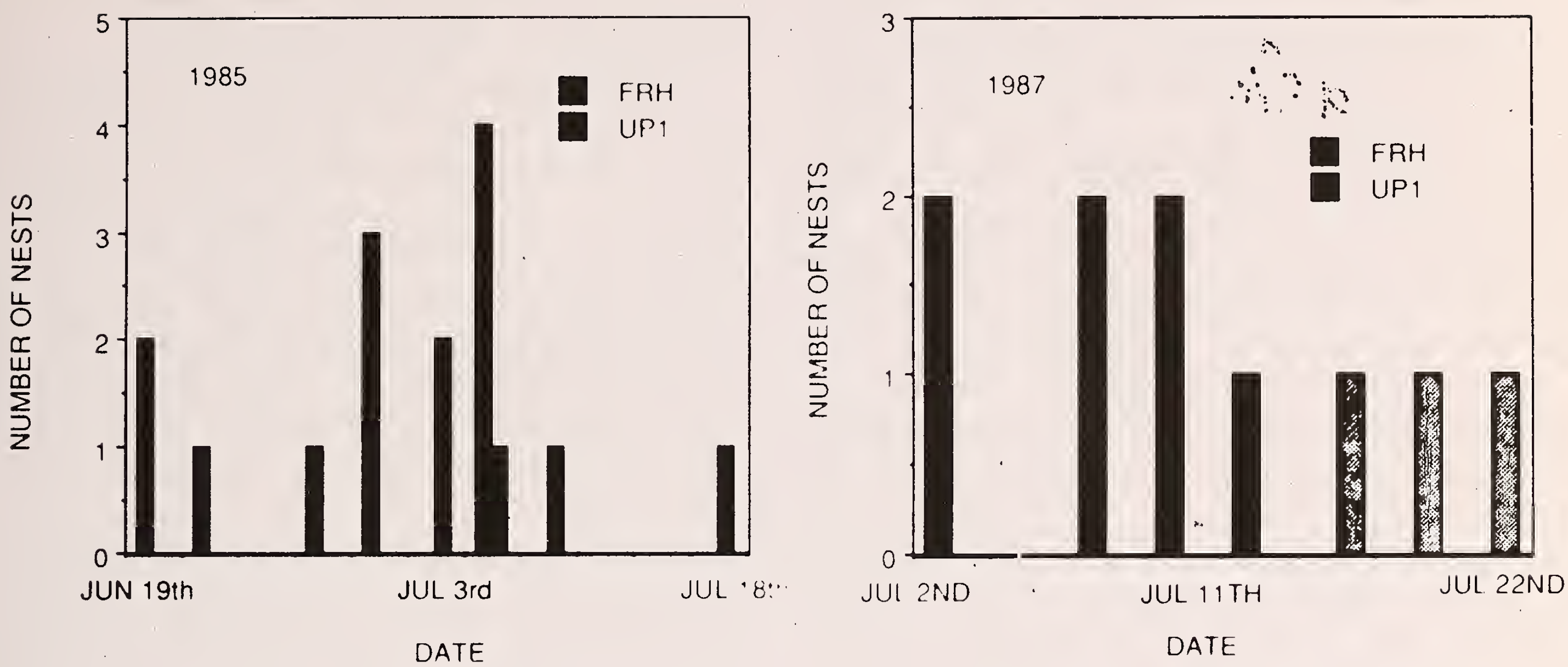

Fig. 5. Distributions of fledging dates for *P. occipitalis* at *c.* 2800 m altitude in fir forest (FRH) and *c.* 3200 m altitude in birch forest (UP1). Above: 1985 (Median date at FRH=July 1; at UP1=July 8; *t* test for significance of means, t=2.3, N=16, p< 0.05). Below: 1987 (Median date at FRH=July 7; at UP1=July 20; t=4.7, N=10, p< 0.01).

Males sing two songs. We also noted rare distinct songs. In particular one individual sang a long (> 1 minute) rambling warble.

Phylloscopus proregulus: Prior to breeding, and sometimes when the weather deteriorates early in the breeding cycle, birds may be found in large flocks of sometimes more than 100, feeding commonly in the undergrowth as well as in conifers. These flocks often contain a few tits *Parus* spp. and goldcrests *Regulus regulus.*

Males sing two songs. One is a thin trill preceded by a *tit tit tit,* similar but much weaker than the song of *P. pulcher,* and the other is a long rambling song of chirps and twitters lasting up to 15 minutes or more (Martens 1980). This song is often uttered from the top of a very tall fir tree, although we rarely heard snatches from males foraging close to the ground. The first song can be heard whenever the sun shines at least from the beginning of May (when our study began each year). The second song is only heard when nesting begins (it was first heard on 31 May 1985, and 3 June 1986), and like the second song of *P. pulcher* appears to only be uttered on territory. The number of each kind of song heard on a post-dawn 2 km walk through fir forest at *c.* 2500 m are displayed in Fig. 3.

Phylloscopus magnirostris: The species is one of the last to arrive in the Overa Sanctuary each year (Fig. 4 of Price and Jamdar 1990). One nest site was known to have been used in two successive years; two others were not.

Phylloscopus trochiloides: Although the species breeds late, males can be heard singing at low altitudes (e.g. at the Forest Rest House) from early May. Many guide books suggest that *trochiloides* and *magnirostris* are best distinguished by the hook on the upper mandible of *magnirostris.* We have not found this to be a good character. In particular, many *trochiloides* show a hook. More diagnostic is the colour of the base of the lower mandible: yellow in *trochiloides* and pink in *magnirostris.*

Phylloscopus occipitalis: This species breeds commonly through the Sanctuary (Appendix 1). In Table 8 we record the average measurements

of birds caught at two altitudes (and in two different habitats). Individuals in the birch forest at high altitude have longer tarsi and thinner bills than those in the fir at lower altitudes. The birds at low altitude also breed one to two weeks earlier than those at high altitude (Fig. 5). The bases for the differences in morphology and laying date are unclear, but earlier fledging may reflect the better climate earlier in the season at the lower altitude (Price and Jamdar 1990).

Nevertheless, in other bird populations both laying date and morphology are known to be partly under genetic determination (Schluter and Smith 1986, Price *et al.* 1988) and it is possible that there is some genetic differentiation along the altitudinal gradient. The situation merits further investigation. Microgeographic variation in the European *P. trochilus* has been recorded. Ebenman and Nilsson (1981) found that *P. trochilus* on small Swedish islands were smaller in body weight than those on the nearby mainland. Tiainen (1982) showed that male *P. trochilus* are larger in wing length in coniferous than deciduous areas. He did not measure beak characters, and wing length increases with age (Hogstad in press), so his observations may not be comparable with ours.

Although Hume and Oates (1889) stated that the nests of this species are difficult to find. Bates and Lowther (1952) stated that it was 'impossible not to find' numbers of *P. occipitalis* nests, particularly in the fir woods. We have not found it easy to locate nests in this habitat, and suspect that pairs may be using tree cavities and holes quite high above the ground, as we observed on a few occasions.

Our assistants have recorded *P. occipitalis* singing in Overa village by the first week of April. It is common in the Sanctuary before we arrive in May and sings on every fine morning (Fig. 4). Song declines when most of the young have fledged. Apart from the call notes described by Ali and Ripley (1983) there is a call — a nasal *cheeze* — which we have only heard twice: both times when a cuckoo *Cuculus canorus* was near a nest early in the season. The young when fledged have an unusual begging call consisting of a several note chatter.

When ringing young at a nest we once observed dramatic injury feigning by one parent. This is the only record of injury feigning we have in the *Phylloscopus*. In many hours of observation on Darwin's ground finches one of us (T.P.) similarly recorded just one instance of injury feigning (by a cactus finch *Geospiza scandens*, unpublished observations). Such isolated observations suggest that injury feigning as a distraction display may have arisen very early in bird evolution.

Status of *P. reguloides*: A ninth species of *Phylloscopus, P. reguloides,* is listed as occurring in the Vale of Kashmir (Ali and Ripely 1983). *P. reguloides* is the only crowned leaf warbler occurring in Nepal. There are few differences between *P. reguloides* and *P. occipitalis* (Williamson 1974, Ali and Ripley 1983). Sonagrams of songs appear similar (Martens 1980), and the main external difference between them was listed as the extent of white on the third outer tail feather by Williamson (1974) and Ali and Ripley (1983). From examination of museum specimens at the British Museum this did not appear to us to be a good character. Evidence for breeding of *P. reguloides* in Kashmir comes from just two records published before 1910 (Ali and Ripely 1983), and it is largely this evidence (i.e. sympatry with *occipitalis*) which has been used to justify two species. We are convinced that only one species of crowned leaf warbler (i.e. *P. occipitalis*) breeds in the Vale of Kashmir, and think it possible that *P. reguloides* and *P. occipitalis* are in fact conspecific.

Discussion

The main purpose of this paper has been to describe the breeding biology of the leaf warblers occurring in Kashmir. Much of our information agrees with, and extends, that summarised by Williamson (1974) and Ali and

Ripley (1983). However, our observations differ from published information in a number of ways. For example, the habitats occupied by three of the eight species are not those suggested by Gaston (1974) in his investigation of morphology-habitat associations.

The inconspicuousness of these species together with their extreme similarity has resulted in them being ignored by many field workers. There is still a great deal that needs to be learned (for example, incubation and nestling periods are unknown for all species except *P. inornatus*) and many of our observations are based on small sample sizes. Some species (*P. tytleri, P. occipitalis*) are generalists in their range of habitats occupied and placement of nests; the others are more specialised. While generalists are more widely distributed over the altitudinal gradient, there is no good association between abundance and degree of habitat specialisation (*P. tytleri* is one of the less common species, Price and Jamdar 1990).

Differences in morphology, altitudinal range, habitats occupied, timing of breeding, plumage pattern, and song may all enable similar species to coexist in the breeding season. It is very difficult to assess the relative importance of these factors, and the extent to which they are products of species interactions (i.e. examples of character displacement) or incidentally selected (Grant 1972). Some are considered further by Price (in prep.). There are also differences in nest placement and nest construction, and it has recently been suggested that these differences could also promote coexistence through the agency of predation (Martin 1988a, in press). Martin (1988a) showed experimentally that if artificial nests were placed all on the ground or all in the trees they suffered higher nest predation than if some were placed on the ground and some in trees, apparently because predators localise their search. Thus two species could both increase their nesting success by one nesting on the ground and one in trees. Martin's hypothesis that the species are partitioning nesting space seems inapplicable if ground nesters have higher predation rates than tree nesters, because any individual of the ground nesting species which nested in a tree should be selectively favoured.

In some localities *P. pulcher* nests in trees while *P. trochiloides* and *P. inornatus* nest on the ground. At other localities *P. tytleri* and *P. proregulus* nest in the trees while *P. inornatus* nests on the ground. While we do not have comparative rates of predation, several predators are ground specialists, such as the Himalayan weasel *Mustela sibirica* and the viper. It seems likely to us that predation rates are higher on the ground nesters, as has been widely observed in other studies (summarised by Martin 1988b). In addition, at both the localities mentioned the ground nesters are far more abundant than the tree nesters, making density-dependent predator specialisation on ground nesters more likely. Hence the idea that species partition nesting space solely in response to predation seems unlikely. Nest parasitism and other factors affecting reproductive success may be important.

Many questions need to be addressed before we can assess the factors contributing to the abundance and species diversity of this genus in Kashmir. We tentatively suggest that resource and habitat partitioning in the non-breeding season will be found to be of major importance. If this is the case then studies of the changing abundance of these warblers in Kashmir should provide useful environmental indicators as to the state of habitat both in Kashmir, and in the plains of India, where all the species pass their winter.

Summary

We describe the breeding and other characteristics of eight species of leaf warblers (genus *Phylloscopus*), at Overa Wildlife Sanctuary, Kashmir, based on three summers (1985-1987) of study. The species are similar, and differ by a maximum of two-fold in body weight. They are sexually dimorphic in wing length, but

monomorphic in beak characters and body weight. For *P. occipitalis* (which breeds throughout the Sanctuary) individuals at high altitudes have longer tarsi and slimmer beaks than those at low altitudes. The species differ in plumage pattern and song. Three species sing two different songs.

Some species have strict habitat preferences, whereas others are more generalised, and altitudinal ranges vary accordingly. They all build domed nests: some build in trees, and others on the ground, while one (*P. occipitalis*) breeds in holes and cavities on the ground and in the trees. For each species timing of breeding differs among years in relation to the weather. *P. occipitalis* individuals at low altitude breed earlier than those at high altitude. Within each year there is about a two week difference in the average time of breeding of the first and last species to breed.

A number of factors could contribute to the high diversity and abundance of *Phylloscopus* species in Kashmir. With current data we are unable to assess most of these, but we tentatively reject nest predation as being important in leading to species coexistence.

References

Alexander, H.G. (1950): Some notes on the genus *Phylloscopus* in Kashmir. *J. Bombay nat. Hist. Soc. 49:* 9-13.

Ali, S. & Ripley, S.D. (1983): Handbook of the birds of India and Pakistan. Compact editon. Oxford University Press, Delhi.

Baker, E.S.C. (1933): The nidification of birds of the Indian Empire. Vol. 2. Taylor and Francis, London.

Bates, R.S.P. & Lowther, E.H.N. (1952): Breeding birds of Kashmir. Oxford University Press, Delhi.

Brooke, M. de L., & Davies, N.B. (1987): Recent changes in host usage by cuckoos, *Cuculus canorus* in Britain. *J. Anim. Ecol. 56*: 873-883.

Cody, M.L. (1974): Competition and the structure of Bird Communities. Princeton University Press, Princeton, U.S.A.

Ebenman, B. & Nilsson, S.G. (1981): Size patterns in willow warblers *Phylloscopus trochilus* on islands in a south Swedish Lake and the nearby mainland. *Ibis 123:* 528-534.

Gaston, A.J. (1974): Adaptation in the genus *Phylloscopus. Ibis 116:* 432-450.

Grant, P.R. (1972): Convergent and divergent character displacement. *Biol. J. Linn. Soc. 4:* 39-68.

Helb, H-W., Bergmann, H.H. & Martens, J. (1982): Acoustic differences between populations of Bonelli's warblers (*Phylloscopus bonelli,* Sylviidae). *Experientia 38:* 356-357.

Hume, A.O. & Oates, E.W. (1889): The nests and eggs of Indian Birds, 2nd edition Vol. I. Porter, London.

Lack, D. (1971): Ecological isolation in birds. Blackwell, Oxford and Edinburgh.

MacArthur, R.A. (1958): Population ecology of some warblers of northeastern coniferous forests. *Ecology 39:* 599-619.

Martens, J. (1980): Lautausserungen, verwandtschaftliche Beziehungen und Verbreitungsgeschichte asiatischer Laubsanger (*Phylloscopus*). *Fortschritte der Verhaltensforschung* no.22.

Martin, T.E. (1988a): On the advantage of being different: nest predation and the coexistence of bird species. *Proc. Natl. Acad. Sci., U.S.A. 85:* 2196-2199.

Martin, T.E. (1988b): Nest placement: implications for selected life history traits, with special reference to clutch size. *Am. Nat.* 132(6): 900-910.

Martin, T.E. (in press): Process organizing open-nesting bird assemblages: competition or nest predation? *Evol. Ecol.*.

Moller, A.P. (1984): On the use of feathers in birds' nests: predictions and tests. *Ornis Scand. 15:* 38-42.

Osmaston, B.B. (1927): Notes on the birds of Kashmir, part 1. *J. Bombay nat. Hist. Soc. 31:* 975-999.

Owen, D.F. (1954): *Protocalliphora* in birds' nests. *British Birds 47:* 236-243.

Price, T. & Jamdar, N. (1989): Where eight leaf warblers breed. *Hornbill 1989(2):* 7-11.

Price, T. & Jamdar, N. (1990): The breeding birds of Overa Wildlife Sanctuary, Kashmir. *J. Bombay nat. Hist. Soc. 87(1)*: 1-15.

Price, T. & Jamdar, N. (1991): Breeding biology of the yellowbrowed leaf warbler *Phylloscopus inornatus* in Kashmir. *J. Bombay nat. Hist. Soc. 88(1)*: 1-16.

Price, T., Kirkpatrick, M. & Arnold, S.J. (1988): Directional selection and the evolution of breeding date in birds. *Science 240:* 798-799.

Schluter, D. & Smith, J.N.M. (1986): Genetic and phenotypic correlations in a natural population of song sparrows. *Biol. J. Linn. Soc. 29:* 23-36.

Svensson, L. (1984): Identification guide to European Passerines. Marstatryck, Stockholm.

Thielcke, G.K., Wustenberg, K. & Becker, P.H. (1978):

Reaktionen von Zilpzalp und Fitis *(Phylloscopus collybita, Ph. trochilus)* auf verschiedene Gesangsformen des Zilpzalps. *J. Fur Orn. 119:* 213-226.

TIAINEN, J. (1982): Ecological significance of morphometric variation in three sympatric *Phylloscopus* warblers. *Ann. zool. Fennica 19:* 285-295.

TIAINEN, J., HANSKI, I.K. & MEHTALA, J. (1983): Insulation of nests and the northern limits of three *Phylloscopus* species in Finland. *Ornis Scand. 14:* 149-153.

WIENS, J.A. (1977): On competition and variable environments. *Am. Sci. 65:* 590-597.

WILLIAMSON, K. (1974): Identification for ringers. 2. The genus *Phylloscopus*. British Trust for Ornithology, Tring, U.K.

APPENDIX 1

TERRITORY CHARACTERISTICS AND ALTITUDINAL RANGES OF THE EIGHT *Phylloscopus* SPECIES

P. tytleri, Tytler's warbler. This species breeds in hedgerows around Overa village (at 2300 m), in fir trees on the forest edges throughout the Sanctuary, and in the pure birch as high as 3350 m. It is not found in pure coniferous woodland (cf. Gaston 1974). It is most abundant in forest clearings at *c.* 2800 m. In July individuals forage in the juniper above the tree-line.

P. affinis, Tickell's leaf warbler. The species breeds only in juniper, hence it occurs from *c.* 3300 to above .300 m, although it is regularly seen at lower altitudes in May.

P. pulcher, orangebarred leaf warbler. Every territory of this species (more than 30 males observed) has contained rhododendron bushes. The species occurs close to the treeline, where rhododendron is most abundant (3400-3600 m). All but one territory has also contained birch, but pure birch and areas with few rhododendrons (e.g. at 3300m at UP1) are not occupied.

P. inornatus, yellowbrowed leaf warbler. Every territory of this species has contained birch trees (more than 300 territories observed), hence it occurs from c. 3100 to c. 3600 m (tree line). Many territories may contain many conifers, but pure conifer stands are not occupied.

P. proregulus, Pallas's leaf warbler. Breeds only in coniferous trees, and occurs commonly throughout the coniferous woodland from where they start in the Sanctuary at *c.* 2300 m. Some pairs breed in isolated tall firs surrounded by predominantly birch trees (in which they forage) as high as 3350 m.

P. magnirostris, largebilled leaf warbler. Intimately associated with watercourses, and occasionally dry valleys, from *c.* 2400 m up to *c.* 3300 m. Forages in both birch and conifers.

P. trochiloides, dull green leaf warbler. Occurs in birch mostly at the treeline, but recorded as low as 3300m. Apparently breeds only in the wetter areas.

P. occipitalis, large crowned leaf warbler. Occurs from Overa village (*c.* 2300 m), where it breeds in houses, throughout the coniferous woods, and also in the birch up to *c.* 3350 m. It breeds close to, but not right at the treeline.

NOTE.- Based mainly on casual observations of at least 30 territories for each species.

NEW DESCRIPTIONS

TWO NEW SPECIES OF *ASIALEYRODES* CORBETT (ALEYRODIDAE : HOMOPTERA) FROM INDIA[1]

K. REGU AND B.V. DAVID[2]

(With two text-figures)

Corbett (1935) erected the genus *Asialeyrodes* for two species of whiteflies *Asialeyrodes lumpurensis* and *A. selangorensis* from Kuala Lumpur, the type species being *Asialeyrodes lumpurensis.* Takahashi (1942) added two species *A. euphorbiae* and *A. multipori* from Thailand and suggested a new combination *A. maesae* for *Pseudaleurolobus maesae* Takahashi from Taiwan, and in 1949 he added one more species *A. corbetti* from Riouw Islands.

Two species of aleyrodids collected from *Ixora brachiata* Roxb. (Rubiaceae) at Cherrapunjee, Meghalaya, on 21 October 1989 have been found to be new and are described in this paper.

Asialeyrodes meghalayensis sp. nov. (Fig. 1)

Pupal case: Dark brown, subcircular, a thick fringe of white wax around the margin, a clump of wax on the junction of longitudinal and transverse moulting suture area and a thin layer of powdery wax on dorsum; glued to the leaf surface; found singly or in groups on the lower surface of leaves; 0.98-1.17 mm long and 0.80-1.03 mm wide.

Margin: Crenate, 9 crenations in 0.1 mm; anterior and posterior marginal setae 15 and 22.5 μ long respectively. Thoracic and caudal tracheal pores present.

Dorsal surface: Four pairs of setae – cephalic and first abdominal setae 75 μ long each, eighth abdominal setae 42.5 μ long and submarginal caudal setae 22.5 μ long. Submargin separated from dorsal disc by a complete furrow. Submargin with a row of pores and porettes near margin evident. Nine pairs of submarginal setae – one each on cephalus, mesothorax, metathorax, abdominal segments 1 and 4-8, 60-70 μ long. Longitudinal and transverse moulting sutures reaching submargin. Submedian pockets present on all segment sutures. A pair of depressions present on mesothorax and metathorax. Dorsum contains full of polygonal markings. Dorsal disc with sparsely distributed pores and porettes evident.

Vasiform orifice subcordate, wider than long, 37.5-40 μ wide and 30 μ long; operculum similarly shaped, 27.5 μ wide and 22.5 μ long, concealing the lingula. Lateral wall of vasiform orifice ridged. Caudal tracheal furrow 107.5-112.5 μ long with polygonal markings.

Ventral surface: Paired ventral abdominal setae 20-22.5 μ long and 37.5-40 μ apart. Thoracic and caudal tracheal folds with stipples evident.

Host: *Ixora brachiata* Roxb. (Rubiaceae)

Material examined: Holotype. *Ixora brachiata*, Cherrapunjee (Meghalaya), 21 October 1989, Coll. B.V. David.

Paratypes: Six pupal cases on slides bearing the same details as of holotype.

This species resembles *Asialeyrodes maesae* (Takahashi) in the colour and shape of the pupal case but differs in the presence of nine pairs of long submarginal setae, submedian depressions and the presence of caudal tracheal furrow with markings and thoracic and caudal tracheal folds with stipples.

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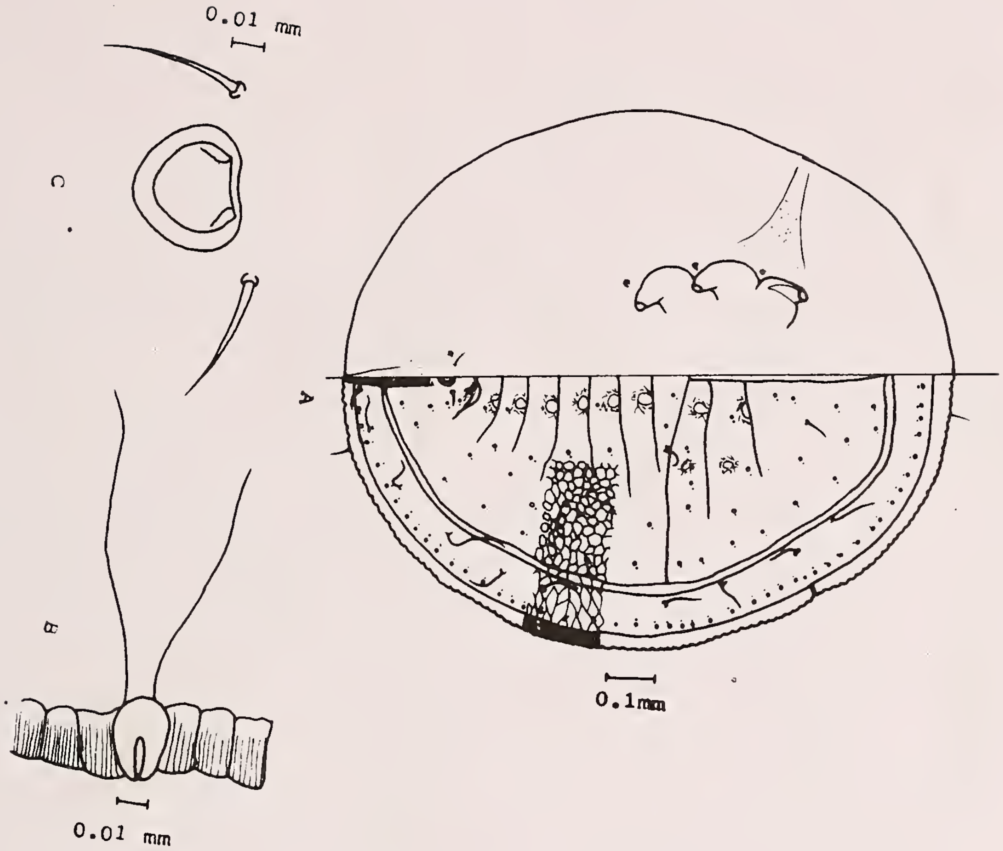

Fig. 1: *Asialeyrodes meghalayensis* sp. nov. A. Pupal case, B. Margin with thoracic tracheal pore, C. Vasiform orifice.

Asialeyrodes papillatus sp. nov. (Fig. 2)

Pupal case: Milky white with a thin layer of wax over the submargin; subcircular, broadest at the transverse moulting suture area, 0.82 mm long and 0.71 mm wide; found on the lower surface of leaf.

Margin: Smooth; anterior and posterior marginal setae 12.5 µ long each; thoracic and caudal tracheal pores with chitinised rim.

Dorsal surface: Two pairs of setae – cephalic and eighth abdominal setae each 2.5 µ long; first abdominal and caudal setae absent. Submargin separated from dorsal disc by a broad and complete furrow. Submarginal furrow contains full of thick papilla-like (3-4 rows) structures. Longitudinal and transverse moulting sutures reaching submargin. Abdominal segment sutures 1-6 are marked by thin papilla-like structures. From the first abdominal segment suture a row of papilla-like structures extends to the cephalic region. A row of four pairs of subdorsal setae near the submargin on abdominal segments 4-8, 2.5 µ long each. Dorsum contains full of polygonal markings. Submargin with a row of about 27 pairs of pores and porettes near the submarginal furrow and dorsal disc with about 44 pairs of pores and porettes – 20 on the cephalothorax and 24 on the abdomen, sparsely distributed.

Vasiform orifice subcircular, wider than long, 40 µ wide and 25 µ long; operculum similarly shaped, filling the orifice, concealing the lingula. Lateral wall of vasiform orifice ridged. Caudal tracheal furrow long, 87.5 µ with small dotted markings. Thoracic tracheal furrow slightly discernible.

Ventral surface: Paired ventral abdominal setae 5 µ long and 35 µ apart. Thoracic tracheal folds distinct, whereas caudal tracheal fold indistinct. Round markings on dorsal disc evident. A minute seta at the base of each mesothoracic and

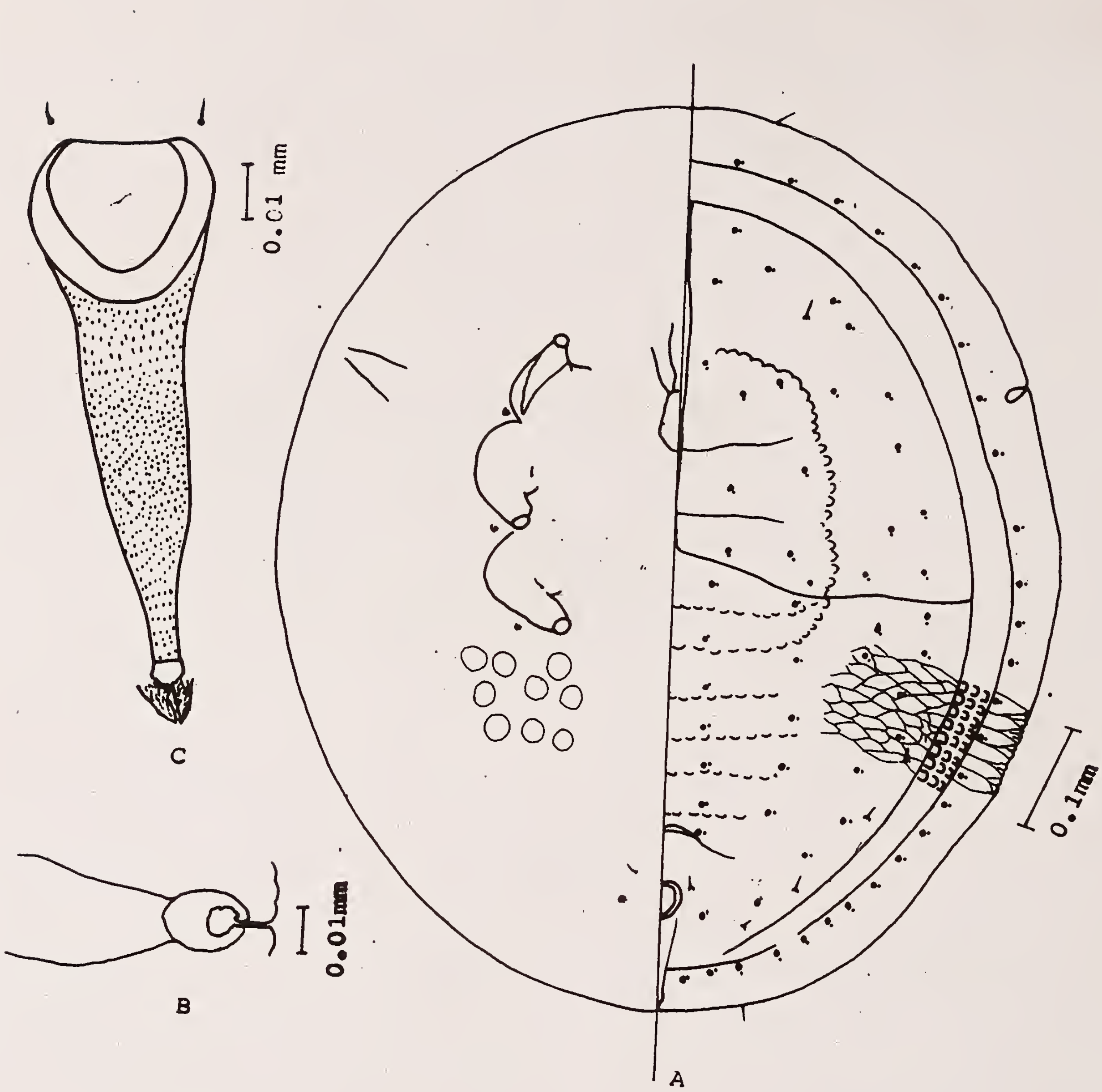

Fig. 2: *Asialeyrodes papillatus* sp. nov. A. Pupal case, B. Margin with thoracic tracheal pore, C. Vasiform orifice with caudal tracheal furrow.

metathoracic leg 3.75 μ long.

Host: *Ixora brachiata* Roxb. (Rubiaceae)

Material examined: Holotype. *Ixora brachiata*, Cherrapunjee (Meghalaya state), 21 October 1989, Coll. B.V. David.

This species differs from all the other known species of *Asialeyrodes* in the presence of papilla-like structures in the submarginal furrow.

ACKNOWLEDGEMENTS

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REFERENCES

CORBETT, G.H. (1935): Malayan Aleyrodidae. *J. fed. Malay St. Mus. 17:* 841-843.

TAKAHASHI, R. (1942) : Some foreign Aleyrodidae (Hemiptera) VI. Species from Thailand and French Indo-China. *Trans. nat. hist. soc. Formosa 32* : 204-207.

TAKAHASHI, R. (1949) : Some Aleyrodidae from the Riouw Islands (Homoptera). *Mushi 20*: 51-52.

A NEW GENUS OF HARPACTORINAE (HETEROPTERA : REDUVIIDAE) FROM SOUTHERN INDIA[1]

DUNSTON P. AMBROSE AND S.J. VENNISON[2]

(With a text-figure)

A new reduviid genus, namely *Neovillanovanus* gen. nov. and a new species, *N. macrotrichiatus* sp. nov. of the division Euagorasaria of the sub-family Harpactorinae is described and illustrated. A key to the Indian genera of the division Euagorasaria is also given.

INTRODUCTION

Distant (1902, 1910) has defined the division Euagorasaria as a group of genera which have as common characters: the head armed with a spine or tubercle behind the base of each antenna; all are more or less elongate insects and have the lateral pronotal angles spinous or at least prominent. He has described 16 genera. In the present paper, a new genus *Neovillanovanus* and a new species *Neovillanovanus macrotrichiatus* having the above divisional characters are described and illustrated. All measurements are given in millimetres.

KEY TO THE INDIAN GENERA OF THE DIVISION EUAGORASARIA OF THE SUB-FAMILY HARPACTORINAE:

A key has been formulated to identify the Indian genera of the division Euagorasaria based on our examinations and also from the information given in Distant's FAUNA OF BRITISH INDIA volumes.

1. Anterior lobe of pronotum posteriorly bituberculated; anterior femorae strongly incrassated; anterior tibiae incurved and spined before apex .... *Rihirbus* Stal
   Anterior lobe of pronotum posteriorly not bituberculated; anterior femorae not or a little incrassated; anterior tibiae simple and not inwardly spined before apex 2
2. Anterior lobe of pronotum prominently tuberculous on each side .....*Isyndus* Stal
   Anterior lobe of pronotum not prominently tuberculous on each side 3
3. Pronotum discally armed 11
   Pronotum discally unarmed 4
4. Anterolateral pronotal margin with one tubercle; anterior femorae and tibiae longly acutely spined .....*Gallobelgicus* Distant
   Anterolateral pronotal margin without tubercle; anterior femorae and tibiae unarmed 5
5. First rostral segment considerably shorter than the second 6
   First rostral segment longer than the second 7
6. Antennal base with a tubercle behind; lateral angles of posterior lobe of pronotum armed with a long spine
   ....*Euagoras* Burmeister
   Antennal base spined behind; posterior lobe of pronotum unarmed
   ....*Macracanthopsis* Reuter
7. Head shorter than pronotum 8
   Head about as long as pronotum 9
8. Ante-ocular and post-ocular areas of head about equal in length; lateral pronotal angles prominent but not spinous...*Cydnocoris* Stal.
   Post-ocular area of head about half as long as ante-ocular area; lateral pronotal angles spinously produced 10
9. First rostral segment very much longer than the second; pronotum, scutellum, corium and clavus clothed with clusters of yellowish hairs ...*Neovillanovanus* gen. nov.

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First and second rostral segment subequal; pronotum, scutellum, corium and clavus devoid of yellowish clusters of hairs .... *Endochus* Stal

10. Posterior angles of pronotum longly porrectly spinous .... *Serendiba* Distant
Posterior angles of pronotum shortly spinous .... *Villanovanus* Distant

11. Only posterior lobe of pronotum discally armed 12
Both anterior and posterior lobes of pronotum discally armed 17

12. Posterior lobe of pronotum discally spined 13
Posterior lobe of pronotum discally bitaberculated .... *Nagusta* Stal

13. Head about as long as pronotum 14
Head shorter than pronotum 15

14. Post-ocular area little longer than ante-ocular area; hemelytra passing the abdominal apex .... *Platerus* Distant
Post-ocular area much longer than ante-ocular area; hemelytra not quite reaching the abdominal apex .... *Lanca* Distant

15. Scutellum unarmed .... *Epidaus* Stal
Scutellum armed with a suberect spine . . .16

16. Scutellum with a single suberect spine; first rostral segment much longer than second .... *Alcmena* Stal
Scutellum with two spines; first and second rostral segments unequal..*Occamus* Distant

17. Ante-ocular and post-ocular areas of head about equal in length; lateral margins of abdomen dilated .... *Brassivola* Distant
Post-ocular area longer than ante-ocular area of head; abdominal margins not dilated .... *Bartacus* Distant

Neovillanovanus gen. nov.

Body elongate; head about as long as pronotum, spined on each side behind the base of each antenna; post-ocular longer but not quite twice as long as ante-ocular portion; antennae with a first segment equal to the posterior femora, pronotum with the rugulose posterior lobe nearly twice as long as the sculptured anterior lobe clothed with yellowish hairs in cluster; disc of posterior lobe unarmed; anterior femorae a little incrassated, and as long as the scape; anterior tibiae a little shorter than anterior femorae and moderately curved.

The new genus is allied to *Villanovanus* by the following characters: anterior pronotal lobe strongly sculptured, anterior tibiae moderately curved and a little shorter than posterior femorae. It can be recognised from *Villanovanus* by the following characters: head as long as pronotum; post-ocular area longer but not quite twice as long as ante-ocular portion; pronotum, prosternum, disc of scutellum, corium and clavus clothed with a thick cluster of yellowish short hairs.

Neovillanovanus macrotrichiatus sp. nov. (Fig. 1)

Piceous; apex of head beneath, rostrum (except extreme apex), basal margin of pronotum, apex of scutellum, lateral corium and veins; and connexivum (except piceous spot) pale luteous; markings in the scape and pedicel brightly ochraceous.

Head elongated (4.4) cylindrical, post-ocular area (2.5) longer than ante-ocular area (1.8) and are demarcated by a transverse sulcus in between the compound eyes; compound eyes protruding laterally; a pair of lateral ocelli located on a slightly elevated portion well behind the eyes; a prominent spine at the base of each antenna; antennae long and slender (25.8) scape and pedicel annulated, finely pilose, scape the longest (10.4), second flagellar segment the shortest (3.3); first rostral segment longer (2.6) than the second (1.5), third segment the shortest (0.7), scarcely pilose.

Pronotum subtriangular, transverse before the middle: pronotum with the posterior lobe (2.5) nearly twice as long as anterior lobe (1.3), the latter strongly sculptured and basally medially impressed anterolateral angles rounded; posterolateral areas posterior lobe with horizontally spined (0.7) posterolateral angles slightly

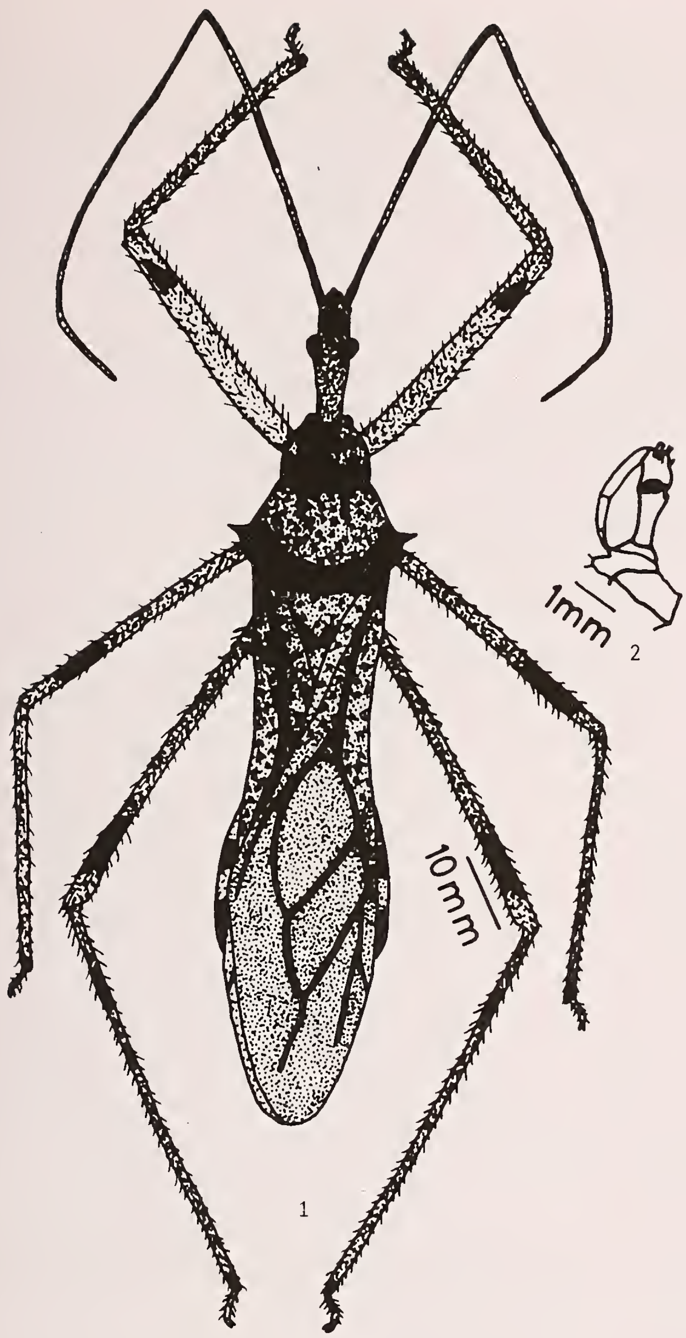

Fig. 1. *Neovillanovanus macrotrichiatus* sp. nov. 1. female, 2. head and pronotum lateral aspect.

tuberculous; pronotum discally unarmed, scutellum (1.8) triangular, its apex obtuse, hemelytra (20.6) passing the abdominal apex; veins distinct on corium and membrane; membrane slightly bronzy and strongly rugulose; pronotum, prosternum, disc of scutellum, corium and clavus clothed with thick clusters of short yellowish hair; legs long and slender; femora apically and hind tibiae basally annulated; fore femora (9.2) a little incrassated and slightly longer than fore tibia (8.5); mid leg the shortest, hind leg the longest; tarsus three segmented; first segment the shortest (0.2) and third the longest (0.4); finely pilose.

Abdomen (14.8) a little elongated, narrowed basally; dilated medially and rounded apically; scarcely pilose; segmentation clear; connexivum narrow and spotted.

Type: Holotype : female, collected from Lower Kodayar, a tropical rain forest of Kanyakumari District, Tamil Nadu, on 6 May 1988, India. Allotype : not collected. Holotype is at present pinned and deposited at the reduviid collections of Entomology Research Unit, St. Xavier's college, Palayankottai, South India.

Etymology: The generic name *Neovillanovanus* is given from its affinities to the genus *Villanovanus* and specifically it is named *macrotrichiatus* from the presence of the peculiar clusters of yellow hairs in pronotum, prosternum, disc of scutellum, corium and clavus.

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REFERENCES

DISTANT, W.L. (1902) : Fauna of British India, Rhynchota, Vol. II, Heteroptera. Taylor & Francis, London. pp. 359-379.

DISTANT, W.L. (1910) : Fauna of British India, Rhynchota, Vol. V. Heteroptera, Appendix. Taylor & Francis, London. pp. 208-216.

A NEW SPECIES OF THE GENUS *HETERANTHURA* KENSLEY (CRUSTACEA: ISOPODA: ANTHURIDAE) FROM VISAKHAPATNAM COAST[1]

K. SHYAMASUNDARI, C. JALAJA KUMARI, K. HANUMANTHA RAO AND A. MARY[2]

(With ten text-figures)

A new species of the genus *Heteranthura* Kensley belonging to family Anthuridae is described. *Heteranthura neoanomalus* sp. nov. is compared with *H. anomala* Kensley, 1980. Three female specimens were collected from the sponge *Prostylyssa foetida* along the rocky intertidal region of Rishikonda, Visakhapatnam.

The genus *Heteranthura* was established by Kensley (1980), the characteristic features being as follows:

Eyes present, antennular flagellum 6-articulate; antennal flagellum 4-articulate. Mouth parts somewhat produced anteriorly. Mandible columnar, lacking palp, lacinia and molar. Maxilliped slender-elongate, 7-segmented, lacking endite. Pereonites 1-6 each with mid-dorsal pit. Pereopods 1-3 subchelate; pereopods 4-7 with carpus more or less rectangular, not underriding propodus. Pleonites 1-6 free, pleopod 1 rami fused, operculiform.

Heteranthura anomala was described from the Indian Ocean (along with some live coral, sponges and alcyonarians) by Kensley (1980), its salient features being the loss of a palp on the strong columnar mandible, which has also lost all trace of a lacinia or molar, maxilla also columnar and distally curved towards the midline, with the teeth meeting just below the mandibular cusps; maxilliped having lost the usual role of ventral shield, slender and delicate and with a few terminal setae, probably plays only a sensory role on feeding.

In the present study, some specimens of an anthurid belonging to the genus *Heteranthura* have been collected off Visakhapatnam coast, south India. Since they differ significantly from *H. anomala* Kensley, they are described as of a new species, *Heteranthura neoanomalus*.

Heteranthura neoanomalus sp. nov.

FEMALE: Length 9 mm; breadth 2 mm.

Body elongate and narrow; integument indurate; pereonites 1, 2, 3, subequal; pereonites 1 and 4 equal; pereonite 5 slightly longer than and pereonite 6 slightly shorter than pereonite 4, pereonite 7 shortest of all. Cephalon with broadly rounded anterior margin, rostrum low and rounded.

Antennule elongate-slender, peduncle 4-articulate, articles 1 and 2 subequal, article 3 about thrice the length of the basal article, article 4 slightly longer than basal article, flagellum 4-articulate.

Antenna little longer than antennule, peduncle 3-articulate, the basal article longest. Flagellum 5-articulate.

Mouth parts, when viewed laterally, elongate and drawn out antero-dorsally beyond anterior margin of cephalon beneath shield- like upper lip.

Mandible lacking palp, strongly indurate, armed distally with 3-4 strongly and a few small sclerotized cusps. Maxilla elongate, indurate, distally strongly curved, armed with one very strong and 4 smaller spines. Maxilliped very elongate-slender, about 10 times as long as wide, 6-articulate, terminal article tiny.

Pereopod 1 uniquis, 3/4 length of dactylus, propodus elongated, palm straight, unarmed except for sensory spines. Pereopods 2-7 gradually increase in length, pereopods 2-7 subsimilar.

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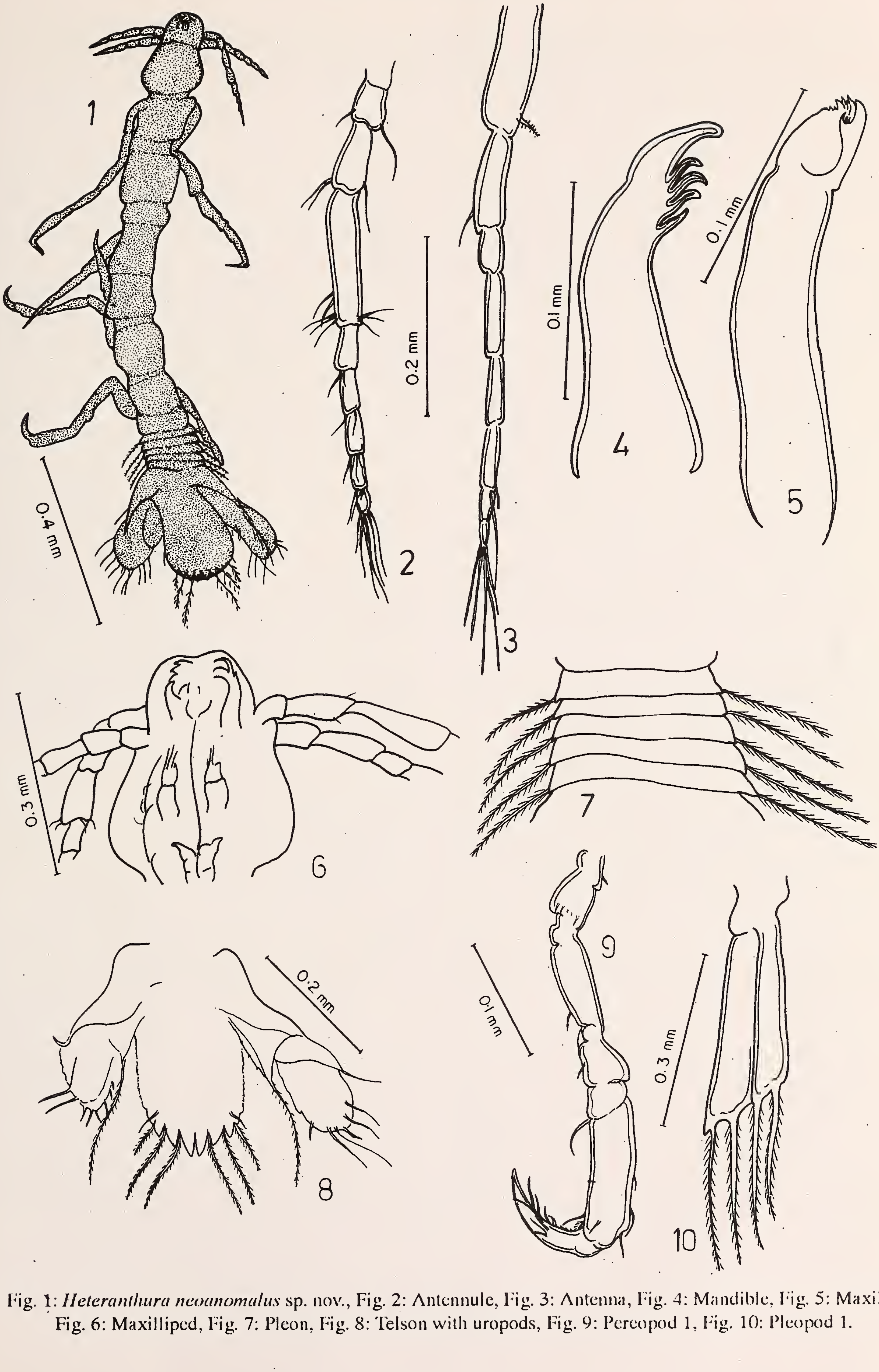

Fig. 1: *Heteranthura neoanomalus* sp. nov., Fig. 2: Antennule, Fig. 3: Antenna, Fig. 4: Mandible, Fig. 5: Maxilla, Fig. 6: Maxilliped, Fig. 7: Pleon, Fig. 8: Telson with uropods, Fig. 9: Pereopod 1, Fig. 10: Pleopod 1.

Pleonites free, subequal, each with prominent plumose seta laterally. The exopod and endopod of pleopod 1 not fused, both provided with two plumose setae each, not operculiform.

Telson shows fine serration on parallel sides, the posterior margin rounded and exhibits dentation, 8 in number, from between two consecutive ones arises a prominent plumose seta. Setae six in number, a few simple setae also present, at the mid-apical region plumose seta present.

Uropodal exopod folds dorsally over telson, bipartite consisting of elongate, spike-like, basally irregular dorsal part, and a rounded ventral part at the apex of which a very long plumose seta is given off on either side, these exceed the posterior margin of telson: endopod oval, distally rounded, margin irregular or finely serrated, extending almost to or up to posterior margin of telson.

Localities: The specimens were collected from the rocky intertidal region of Rishikonda, Visakhapatnam.

Material studied: Three female specimens were collected from the sponge *Prostylyssa foetida* along the rocky intertidal region of Rishikonda, Visakhapatnam. Holotype 1 female and paratypes 2 females are kept in the Department of Zoology, Andhra University, Waltair. They will be deposited in the collections of the Zoological Survey of India, Calcutta.

Habitat: The specimens were found in association with the sponge *Prostylyssa foetida* along the rocky intertidal region of Rishikonda, Visakhapatnam.

Discussion

Heteranthura neoanomalus sp. nov. resembles *Heteranthura anomala* Kensley, 1980 in the anteriorly produced mouth parts, and the mandible which lacks palp: the maxilla is elongated, indurate and distally strongly curved and the pleonites is provided with lateral plumose setae. Several differences can be detected, however, which separate the two species. These include the segmentation of antennules and antennae; in the number of spines for maxilla, and number of sclerotised cusps of mandible, the length of dactylus of pereopod 1 in the present form is not fused as described in *H. anomala*, and is provided only with two plumose setae each, the exopod of uropod bears a very long plumose seta, the posterior extremity of endopod is not acute and the posterior margin of telson is dented rather than serrated.

Since the differences observed are significant, a new species has been created for the specimens collected by us.

Acknowledgements

One of us (C.J.K.) is grateful to the Council of Scientific and Industrial Research for financial assistance. We are thankful to the authorities of Andhra University for providing facilities.

References

Kensley, B. (1980): Anthuridean isopod crustaceans from the International Indian Ocean Expedition, 1960 - 1965 in the Smithsonian collection. *Smithson. Contrib. Zool. 304:* 1-37.

A NEW SPECIES OF *LEYCESTERIA* WALL. (CAPRIFOLIACEAE) FROM ARUNACHAL PRADESH[1]

S.K. DAS AND G.S. GIRI[2]

(With a text-figure)

A new species of *Leycesteria* Wall. is described and illustrated. A key to the six species under the genus *Leycesteria* Wall. is also given for easy diagnosis.

Leycesteria dibangvalliensis sp. nov.

Affinis *L. stipulatae* (Hook. f. & Thoms.) Fritsch, sed ramis conspicue fistulosi, plus minus glabris, stipulis magnis, stylo pubescente differt.

Typus: Holotypus lectus S.K. Das ad locum Arunachal Pradesh, Dibang Valley district, Tiwari Gaon, Mahao Sanctuary, c. 1500 m, die 3.1.1988, sub numero 2903, et positus in CAL. Isotypi positus in ARUN.

Scandent shrubs, 1.5-2.5 m; branches terete, striate, conspicuously fistulose, sparsely glandular pubescent particularly at and near nodes, often glabrate or glabrous internodes and older parts; bark thin, dull grey. Leaves simple, stipulate, opposite superposed, nearly equal in pair, ovate to ovate-lanceolate, (8-) 12-15 (-20) x (4-) 7-9 (-12) cm, equilateral or slightly inequilateral; base rounded to subcordate; apex acuminate to caudate-acuminate; margin dentate, teeth ending in distinct gland, often recurved; venation pinnate, 4-8 nerves arise from base of lamina or 2-4 nerves arise from base and 2-4 nerves sub-basal, in addition to basal nerves 4-6 lateral nerves on either side of midrib; upper surfaces of lamina rugose or rugulose due to impressed reticulations, lower surfaces alveolate due to raised reticulations; lamina thinly coriaceous, on drying turn dull green above and grey to brown beneath; upper surfaces glabrous except pubescent nerves, lower surfaces densely lanuginous throughout, hairs soft, crisped; petioles strongly channelled, (2-) 4-6.5 (-7.5) mm long, sparsely to densely puberulous. Stipules interpetiolar, foliaceous, distinctly unequal in pair, often basally adnate with the petioles, orbicular to suborbicular, reticulations and texture nearly as those of leaves, margin subentire to denticulate, recurved; larger of the pair often reflexed downward, adpressed with branches, (6-) 10-17 (-21) x (9-) 18-25 (-29) mm; smaller of the pair always erect, (4-) 6-14 (-16) x (4-) 9-20 (-22) mm.

Inflorescence axillary, pseudo-verticillate, much shorter than subtending leaves, 2-4 cm long peduncles densely clothed with ferrugineous glandular hairs, bracteate, bracteolate, 6 flowers in each whorl; flowers sessile or subsessile; bracts in series at base of each peduncle and remain enclosed by stipules, ovate-acuminate to narrowly triangular, 3-5 x 1.5-2.5 mm, strongly keeled, upper surfaces dense ferrugineously puberulous, lower surfaces glabrous or very sparsely puberulous; bracteole 2-whorled, the bracteoles in outer whorl larger, usually 4, more or less foliaceous, broadly ovate, 5-8 x 3.5-5 mm, base subcordate to truncate, apex acute, margin entire, ciliate, upper surfaces dense ferrugineously puberulous, lower surfaces sparsely puberulous, longitudinally veined, membranous; bracteoles in inner whorl adpressed with the receptacle, smaller, ovate or ovate-oblong, other characters like those of outer whorls. Receptacle ovoid-attenuate, 6-8 x

[1]Accepted May 1991.
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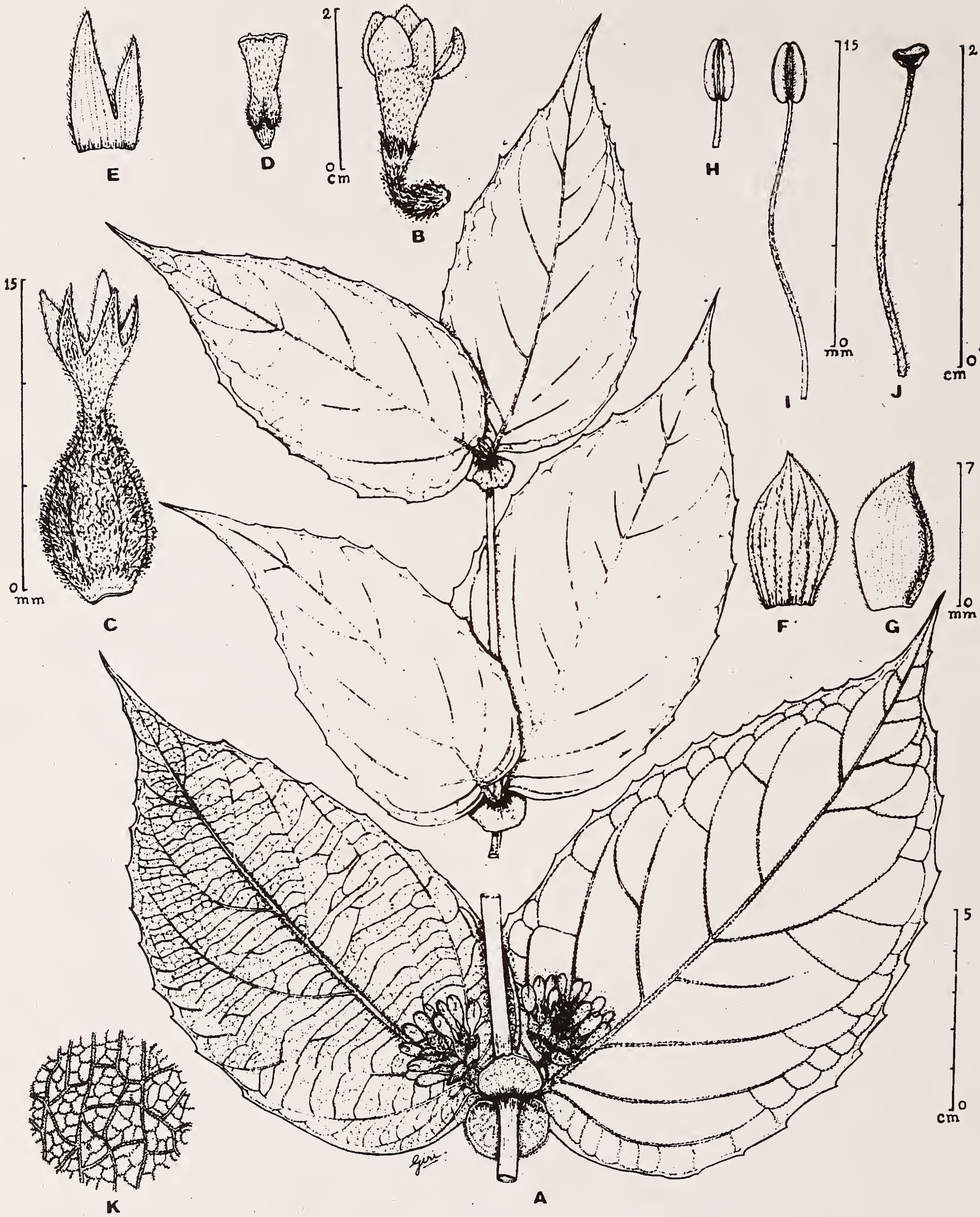

Fig. 1: A – K: *Leycesteria dibangvalliensis* sp. nov.
A: Habit, B: Flower, C: Calyx, D: Basal part of corolla-tube, E: Calyx lobes (Ventral view), F-G: Bracteoles, H: Anther (ventral view), I: Stamen showing hairs along the connective of another dorsally, J: Style & stigma, K: Part of lower surface of leaf (magnified).

3.5-5 mm, straight or slightly curved upward, dense ferrugineously glandular pilose. Calyx concrescent with ovary, calyx-tubes 1-2 mm long, widened towards apices, dense brownish or ferrugineously glandular pilose; 5-lobed, lobes subequal or distinctly unequal, ovate-oblong to narrowly oblong, 3.5-5 x 1-1.5 mm, apex acute, glandular pubescent above, glabrous beneath, longitudinally veined, membranous, usually persistent. Corolla whitish, regular to subregular, campanulate or infundibulariform; corolla-tubes (10-) 12-14 (-17) mm long, gibbous near the base with five nectaries, gradually widened towards apices, dense ferrugineously glandular pilose outside, glabrous or sparsely pilose inside at base; corolla-lobes imbricate, equal or subequal, ovate, 6-7 x 3- 4.5 mm, apex acute or obtuse, glandular pilose outside, glabrous or glabrate inside. Stamens 5; filaments attached at base of corolla-tube, inserted, 13-16 mm long, compressed, sparsely hairy along the whole length or lower part sparsely hairy and upper part densely hairy; anthers remain at the throat of corolla-tube, slightly exerted, oblong, 2.75-3 x 1.5-1.75 mm, basifixed, truncate at both ends, curved hairy along the connective dorsally, glabrous ventrally, longitudinally dehiscent. Ovary 5-loculed, ovules many in each locule; style straight, (16-) 18-21 mm long, exerted, densely barbate towards base, sparsely hairy or even glabrous towards apex; stigma capitate or unevenly lobed. Fruit not seen.

Type: Arunachal Pradesh, Dibang Valley district, Tiwari Gaon, Mahao Sanctuary, *c.* 1500 m, 3 Jan. 1988, *S.K. Das* 2903 (holotype CAL); *S.K. Das* 2903A-2903D (Isotypes ARUN).

Flowers: December-January.

Ecology: This scandent shrub grows in secondary forests and it has been collected at an altitude of *c.* 1500 m.

The new species is closely allied to *L. stipulata* (Hook. f. & Thoms.) Fritsch, but it can be distinguished by the glabrate or even glabrous, conspicuously fistulose branches, large stipules and densely pilose style.

A key to the six species, including the new one described here, is given below for easy diagnosis:

KEY TO THE SPECIES OF *Leycesteria* WALL.

1. Leaves coriaceous, persistent, rugose or rugulose with impressed nerves above, densely lanuginous beneath......................2
1. Leaves herbaceous, deciduous, not rugose above, not lanuginous but pubescent or glaucescent beneath..................................3
2. Branches sparsely to densely woolly, usually solid or at times narrowly fistulose; styles glabrous ....*L. stipulata*
2. Branches glabrate or even glabrous, consistently distinct fistulose; styles pilose........... .... *L. dibangvalliensis*
3. Ovary 5-loculed, densely glandular pubescent; bracteoles equalling or longer than ovary...4
3. Ovary 8-loculed, glabrous, bracteoles shorter than ovary .... *L. gracilis*
4. Stipulate; styles pubescent.........................5
4. Exstipulate; styles glabrous...... *L. formosa*
5. Inflorescence usually axillary, rarely terminal or on short lateral branches; flowers in pairs; stipules very small; corolla whitish .... *L. glaucophylla*
5. Inflorescence terminal; flowers in sixes, pseudo-verticillate; stipules large, foliaceous; corolla orange-yellow.. *L. crocothyrsos*

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TWO NEW SPECIES OF THE GENUS *THOMISUS* WALCKENAER (ARANEAE : THOMISIDAE) FROM COASTAL ANDHRA PRADESH[1]

T.S. Reddy and B.H. Patel[2]

(With two text-figures)

Two new species of the genus *Thomisus* Walckenaer, *Thomisus godavariae* sp. nov. and *T. krishnae* sp. nov. from Srikakulam, Krishna, Guntur, Prakasam and Nellore districts of coastal Andhra Pradesh are described and illustrated.

Introduction

The genus *Thomisus* Walckenaer is represented in Indian fauna by 17 species, out of which two were described by Stoliczka (1869) and the other 15 by Tikader (1960 to 1980), Basu (1963), Sen (1963) and Sen and Basu (1963).

While examining the spider collections made by one of us (TSR) from coastal Andhra Pradesh, we came across two new species of *Thomisus,* which are described and illustrated here. At present the thomisid fauna comprises of six subfamilies, 37 genera and 167 species from India.

The type specimens will in due course be deposited in the National Collections of the Zoological Survey of India, Calcutta.

Thomisus godavariae sp. nov. (Fig. 1)

General: Cephalothorax and legs yellowish, abdomen chalk-white. Total length 8.60 mm. Carapace 3.60 mm long, 3.70 mm wide; abdomen 5.50 mm long, 5.40 mm wide.

Cephalothorax: High, oval, as long as wide. Both rows of eyes recurved, anterior medians light and rest dark in colour; lateral eyes on strong conical protuberance. Anterior median eyes smaller than the anterior lateral eyes. All posterior eyes equal in size. Ocular quad wider than long and wider behind than in front. Clypeus moderately subrectangular and granulated. Centre of the thorax pale in colour (Fig. 1 a). Sternum oblong, yellow, clothed with hairs. Labium and maxillae longer than wide, distal ends chalk-white in colour. Sternum, labium and maxillae as in Fig. 1 b. Chelicerae yellowish in colour and strong. Legs long and stout, I and II longer than III and IV. Metatarsi I and II with six pairs of stout ventral spines. Tibiae I and II with two pairs of ventral spines and two antero-lateral spines in the anterior half. Front view of I leg as in Fig. 1 h. Legs III and IV without any spines. Metatarsi of III and IV with distal end and tarsi with complete scopulae. Two tarsal claws present. Leg formula 1/2/4/3.

Abdomen: Chalk-white, pentagonal, projecting over the base of the cephalothorax in front, broadest just behind the middle. The broadest region is tuberculated laterally with a small dark brown spot on the top of the tubercle. Dorsum of abdomen with one anterior median and three pairs of sigillae. Lateral margins of dorsal surface of abdomen with small tubercle-like granules and muscular corrugations. Posterior end of abdomen with conspicuous muscular corrugations as in Fig. 1 a. Ventral side lighter in colour and provided with two rows of brown dots, six in each row inbetween the epigastric furrow and spinnerets. Ventrolateral margins with corrugations of muscles. Epigyne and internal genitalia as in Fig. 1 c, d.

Male: Similar to female but very small with a total length of 3.16 mm. Male palp as in Fig. 1 e, f, g.

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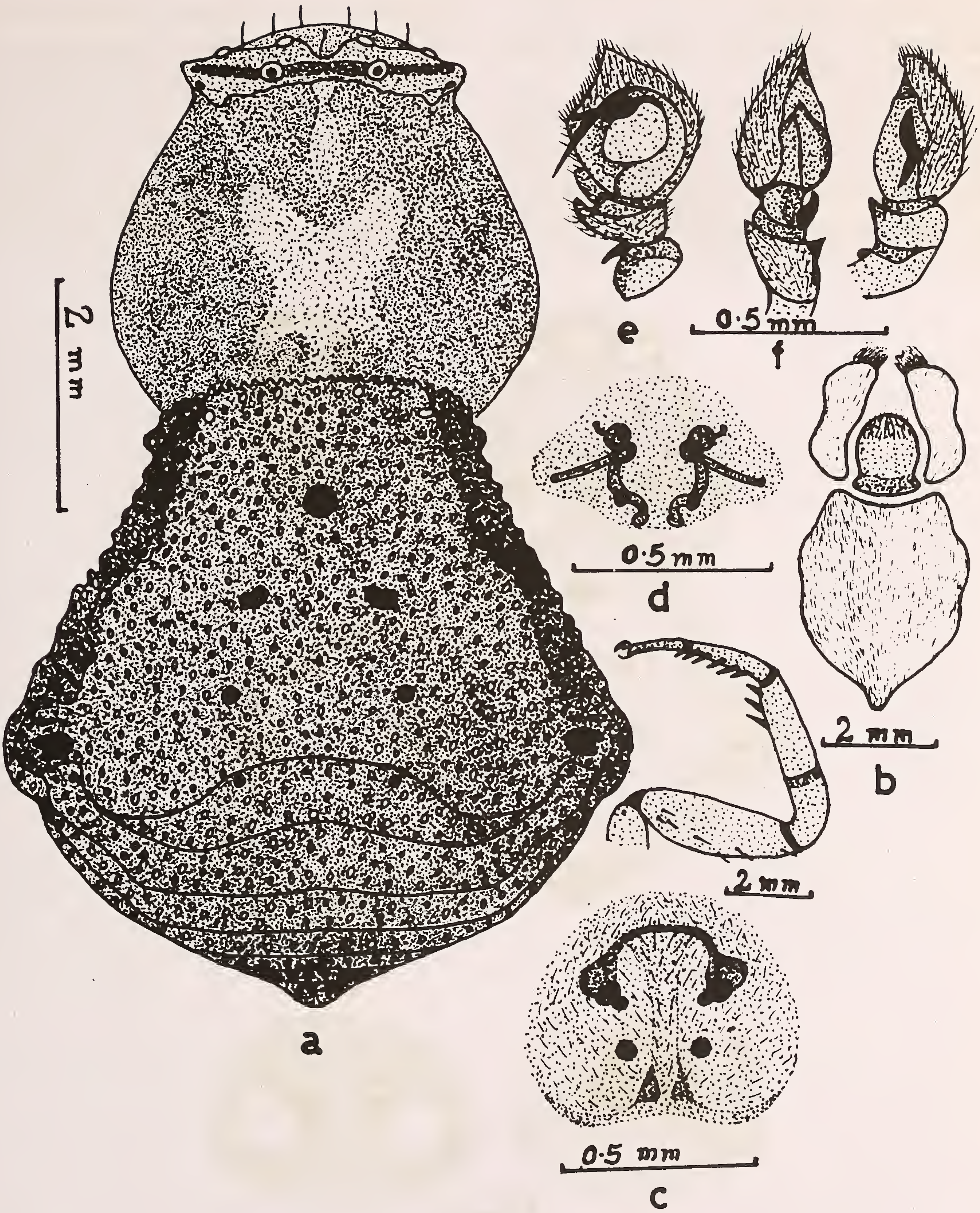

Fig. 1: *Thomisus godavariae* sp. nov.
(a) Dorsal view of female (legs omitted), (b) Sterum, labium and maxillae, (c) Epigyne, (d) Internal genitalia, (e) Right male palp – ventral view, (f) Right male palp –'outerview, (g) Right male palp – inner view, (h) I leg front view.

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Holotype: One female, paratype 12 females, allotype one male in spirit.

Type-locality: Tenali, dist. Guntur, 24 Aug. 1985. Coll. T. S. Reddy.

Distribution: Budumur, dist. Srikakulam, 9 Oct. 1986; Avanigudda, dist. Krishna, 13 Feb. 1986; Tangutur, dist. Prakasam, 10 April 1986; Athmakur and Manubolu, 3 April 1986, Kota, 4 April 1986, Lakshmipuram, 9 Oct. 1986 and Nellore, dist. Nellore, 8 April 1986. Coll. T. S. Reddy.

Diagnosis: The species resembles *Thomisus beautifularis* Basu but is separated as follows. (i) Metatarsus I and II with six pairs of ventral spines but *T. beautifularis* has only five pairs of ventral spines. (ii) Abdomen with one anterior median and three pairs of sigillae but *T. beautifularis* has only three pairs of sigillae. (iii) Epigyne and internal genitalia are also structurally different.

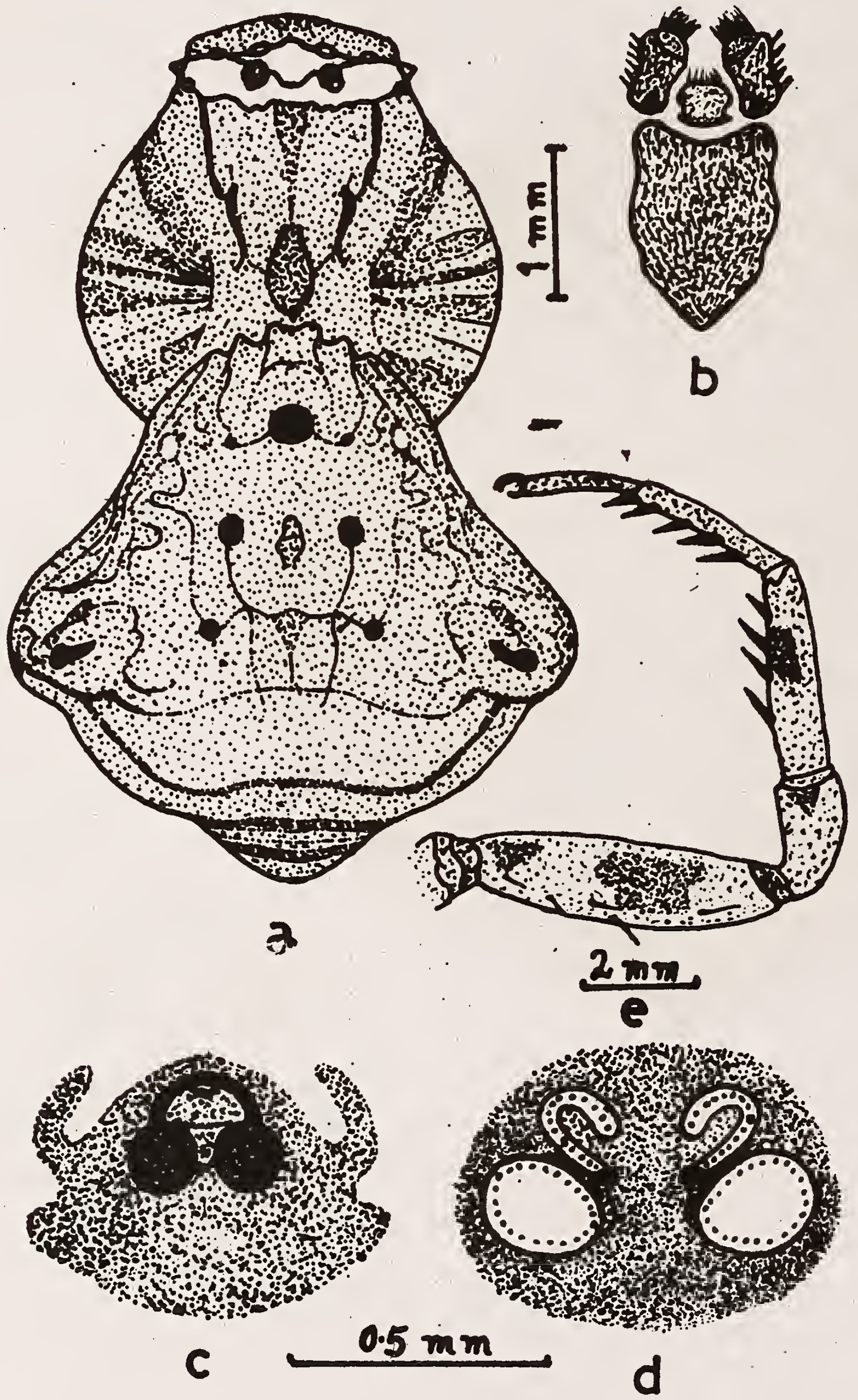

Fig. 2: *Thomisus krishnae* sp. nov. (a) Dorsal view of female (legs omitted), (b) Sternum, labium and maxillae, (c) Epigyne, (d) Internal genitalia, (e) I leg front view.

Thomisus krishnae sp. nov. (Fig. 2a-e)

Cephalothorax and legs yellowish, abdomen chalk-white. Total length 5.60 mm. Carapace 2.75 mm long, 2.70 mm wide; abdomen 3.65 mm long, 3.70 mm wide.

Cephalothorax: Pentagonal in shape, as long as wide, narrowing in front, with a transverse yellow band on ocular area. Eyes black, both rows of eyes recurved but anterior row more recurved than the posterior row. Anterior eyes more or less equal in size. Ocular quad longer than wide, wider behind than in front (Fig. 2 a). Clypeus long and subtriangular. Sternum oblong, pointed behind, chalk-white in colour, clothed with hairs. Labium and maxillae longer than wide, distal ends chalk-white in colour. Sternum, labium and maxillae as in Fig. 2 b. Chelicerae strong, yellowish in colour. Legs long and stout, I and II longer than III and IV. Metatarsi I and II provided with six pairs of stout ventral spines. Tibiae I with four prolateral and two retrolateral spines and II with one pair of ventral spines. Femora I with four dorsal spines. Legs I and II with chalk-white patches on trochanter; basally, median and apically on femur; apically on patella and tibia and on middle of tibia and metatarsus as in Fig. 2 e. Legs III and IV without any spines. Metatarsi and tarsi III and IV provided with scopulae on distal ends. Tarsal claws two. Leg formula 1/2/4/3.

Abdomen: Chalk-white, nearly rectangular, strongly overlapping the posterior region of cephalothorax in front, broadest just behind the middle. The broadest region is tuberculated laterally with a small black spot on the top of the tubercle. Dorsum of abdomen with one anterior median and two pairs of sigillae. Lateral margins and posterior end of abdomen with conspicuous muscular corrugations (Fig. 2 a). Ventral side lighter in colour, with two rows of brown dots, six in each row in between the epigastric furrow and spinnerets. Epigyne and internal genitalia as in Fig. 2 c and d.

Holotype: One female, paratype 8 females in spirit.

Type-locality: Valiveru, dist. Guntur, 15 Feb. 1986. Coll. T. S. Reddy.

Distribution: Vijayawada, dist. Krishna, 28 April 1986; Podili and Tungutur, dist. Prakasam, 27 Mar. 1986 and 10 April 1986 resp.; Nellore, dist. Nellore, 8 April 1986. Coll T. S. Reddy.

Diagnosis: This species resembles *Thomisus andamanensis* Tikader but is separated as follows: (i) Tibiae I with four prolateral and two retrolateral spines whereas *T. andamanensis* tibiae I has four pairs of ventral spines. (ii) Legs I and II with chalk-white patches but *T. andamanensis* lacks chalk-white patches. (iii) Epigyne and internal genitalia are also structurally different.

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REFERENCES

Basu, B.D. (1963): A new spider of the family Thomisidae (Araneae) from India. *Sci & Cult. 29:* 606-607

Sen, J.K. (1963): On a new species from India belonging to the genus *Thomisus* Walckenaer 1805 (Thomisidae : Arachnida). *Sci. & Cult. 29:* 610-611.

Sen, J.K. & Basu, B.D. (1963): *Thomisus mimae* a new spider (Thomisidae: Arachnida) from Calcutta. *Sci. & Cult. 29* (10): 515-516.

Stoliczka, F. (1869) : Contribution towards the knowledge of Indian Arachnoidea. *J. Asiat. Soc. Beng. 38:* 201-251.

Tikader, B.K. (1960): On some new species of spiders (Arachnida) of the family Thomisidae from India. *J. Bombay nat. Hist. Soc. 57 :* 173-183.

Tikader, B.K. (1962): Studies on some Indian spiders (Araneae: Arachnida). *J. Linn. Soc. Lond.* (Zool.) *44:* 561-584.

Tikader, B.K. (1963): Studies on interesting South Indian Crab-spiders (Family: Thomisidae). *Proc. Indian Acad. Sci., B, 58:* 249- 262.

Tikader, B.K. (1964): Zoological results of the Indian Cho-Oyu Expedition (1958) in Nepal, Part 8, Arachnida. *Rec. Ind. Mus. 59* (3): 257-267.

Tikader, B.K. (1965): On some new species of the family

Thomisidae from India. *Proc. Indian Acad. Sci., B, 61*: 277-289.

TIKADER, B.K. (1966) : Studies on some crab-spiders (Family: Thomisidae) from Khasi and Jaintia Hills, Assam, India. *Proc. Indian. Acad. Sci., B, 64* (1): 53-61.

TIKADER, B.K. (1971): Revision of Indian Clab-spiders (Araneae: Thomisidae). *Mem. Zool. Surv. India 15* (3): 1-90.

TIKADER, B.K. (1980): The Fauna of India, Spiders : Araneae, Vol. II, Part I. Govt. of India, New Delhi. pp. 1-247.

COPIDOGNATHUS GITAE, A NEW SPECIES OF HALACARIDAE (ACARI) FROM VISAKHAPATNAM COAST, BAY OF BENGAL[1]

TAPAS CHATTERJEE[2]

(With ten text-figures)

Copidognathus gitae, a new species of halacarids (Acari) is described here from Visakhapatnam coast (Bay of Bengal), collected among the thalli of *Caulerpa racemosa* and *Caulerpa taxifolia*. Similarities and dissimilarities with related species are discussed.

INTRODUCTION

The littoral phytal halacarids of Visakhapatnam coast are not well researched for biosystematic understanding except for the quantitative recording of the group among various algal biotopes (Sarma 1974 a, b, c; Sarma and Ganapati 1972, 1975). However, as many as eight named and six undetermined species were documented in the publications on the interstitial fauna of Visakhapatnam beach sands (Rao 1970, Rao & Ganapati 1968). The present paper is an attempt to study the biosystematics of halacarids along the coast and reports the occurrence of a new species, *Copidognathus gitae* from the phytal realm of the Visakhapatnam foreshore.

Copidognathus gitae sp. nov.*

Diagnosis: AD with long, stout, spine-like frontal elongation; telofemur I with huge pointed ventro-lateral lamella, postero-dorsal plate with 4 longitudinal costae.

Locality: Several male and female specimens were recovered from *Caulerpa racemosa* and *C. taxifolia*, collected in the littoral region of Palm Beach, Visakhapatnam coast, Bay of Bengal. Sediment deposited on the thalli consists of medium sand.

Type: The holotype (male) and paratypes are in the author's collection in the Department of Life Science, Regional College of Education, Bhubaneswar.

Description: MALE: Idiosomal length of males ranged between 256 μ and 290 μ. The various other measurements obtained from one of the male specimens are shown in Table 1.

All dorsal plates separate and are sculptured with fovea and rosette pores (Fig. 1). Anterodorsal plate (AD) bears a long, stout, spine-like frontal projection and three areolae, one located anteriorly and two posteriorly. The

TABLE 1
MEASUREMENTS OF MALE *Copidognathus gitae* SP. NOV.

	Length(μ)	Width (μ)
Idiosoma	271	158
Anterodorsal plate	92	76
Ocular plate	65	47
Posterodorsal plate	158	125
Anterior epimeral plate	73	147
Genitoanal plate	127	25
Genital opening	36	25
Gnathosoma	71	56

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*Named after Miss Gita Chatterjee for her support and devoted interest in the present research.

anterior areola extends nearly upto the tip of the frontal spine and comprises of 16-18 rosette pores (Figs. 1, 4). The two posterior areolae, each comprising 10-11 rosette pores, are divergent antinorly and separated by a narrow gap posteriorly. The dorsal seta 1 (ds_1) are located anterior to two posterior areolae on AD. Ocular plate (OC) bears dorsal seta 2 (ds_2) anteromedially. Two corneae flanked on either side by two areolae are present on OC (Fig 5). Posteriorly, OC tapers acutely up to the insertion of leg III. Posterodorsal plate (PD) is separated from AD by a cuticular membrane consisting of almost parallel striae. PD with 4 costae. The middle costae are of two rosette pores width but at the posterior end they are 3 rosette pores wide. The dorsal setae 3, 4 and 5 (ds_3, ds_4, and ds_5) are on PD. A pair of adanal setae are present on anal papillae.

All ventral plates are separate (Fig. 2). The Ist coxal prominence of Anterior epimeral plate (AE) bears a few rosette pores laterally. AE bears 3 pairs of setae. Posterior epimeral plate (PE) possesses a few rosette pores. PE with 3 ventral and 1 dorsal setae. GA with perigenital areolae. There are 14-17 pairs of perigenital setae (PGS) around the genital opening (GO) besides 4 pairs of subgenital setae (SGS) inside the GO (Fig. 2).

Palp is 4-segmented (Fig. 3). Palpal trochanter and patella are without any setae. Palpal femur is with one dorsal seta; palpal tibiotarsus with 3 basal setae and one distal singlet eupathidia. Rostrum is slender, extending upto the base of palpal patella. Gnathosoma bears a pair of proto-, deuto-, trito-, and basi-rostral setae. The tectum is conical and moderately developed (Fig. 3).

The chaetotaxy of legs I - IV is as follows:

Trochanter	1-1-1-0
Basifemur	2-2-2-2
Telofemur	5-5-2-2
Patella	4-4-3-3
Tibia	7-7-5-5

Tarsus is discussed in the text.

TABLE 2
MEASUREMENTS OF FEMALE *Copidognathus gitae* SP. NOV.

	Length (μ)	Width (μ)
Idiosoma	292	174
Antero-dorsal plate	96	71
Ocular plate	68	46
Postero-dorsal plate	170	139
Anterior epimeral plate	83	158
Genitoanal plate	133	100
Genital opening	46	27
Gnathosoma	72	50

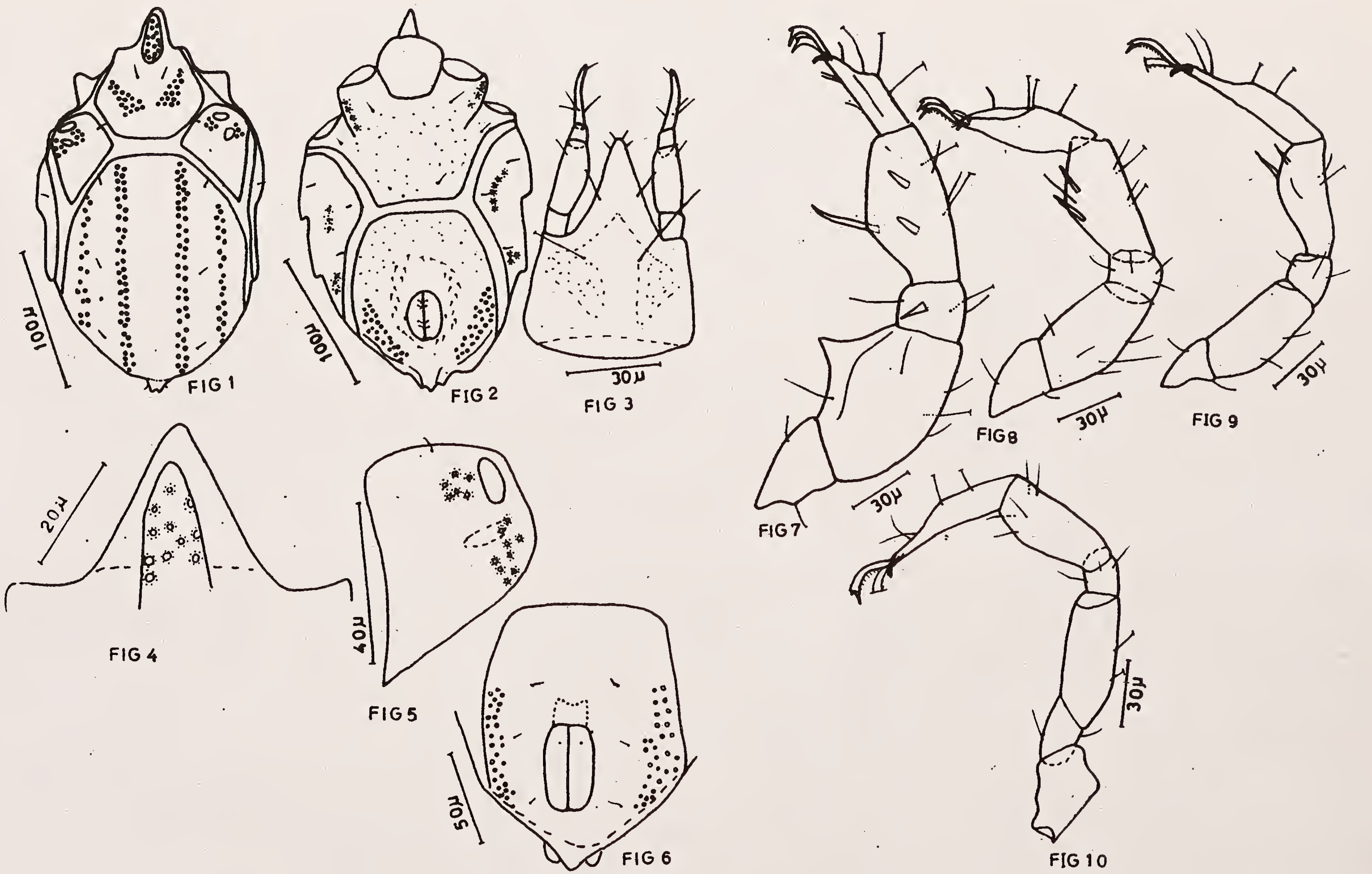
Trochanter III is clavate with a feebly developed postero-dorsal spine. Telofemur I bears a huge pointed ventro-lateral lamella (Fig. 7). Telofemora III and IV devoid of any ventral seta. Tibia I with 4 dorsal hair-like setae and 3 ventral setae (of which one is stout and spine-like, while the other two are acute and moderately developed). Tarsus I is beset with three dorsal long setae; three ventral setae (one basal filiform seta and two singlet eupathidia distally); one solenidion, one profamulus and four parambulacral setae (PAS) (two doublets eupathidia). Tarsus II bears 3 dorsal long setae, 1 solenidion, 2 eupathidia doublets PAS accounting for a total 8 setae (Fig. 8). Tarsi III and IV with 3 dorsal fossary setae, 1 proximo-dorsal and 2 PAS (Figs. 9, 10). Tarsi I-IV bear two lateral claws and one bidentate median claw (Figs. 7-10). Lateral claws of tarsus I are ventrally smooth and bear an accessory tooth dorsally. Lateral claws of legs II, III and IV are pectinate ventrally and bear an accessory tooth dorsally.

FEMALE: The idiosomal length of females ranged between 270 μ and 300 μ. The various other morphometric measurements obtained from a female specimen are shown in Table 2.

Female resembles the male except for the genitoanal region. Genitoanal plate with 3 pairs of PGS and one pair of SGS located anteriorly on GO. Ovipositor is small. Paragenital areolae present (Fig. 6).

DISCUSSION

C. gitae sp. nov. is easily distinguished



Copidognathus gitae sp. nov.

Fig. 1: Idiosoma – dorsal of male, Fig. 2: Idiosoma – Ventral of male, Fig. 3: Gnathosoma, Fig. 4: Magnified view of anterior portion of AD, Fig. 5: Magnified view of OC showing cornea and areolae, Fig. 6: Genitoanal region of female, Fig. 7: Basifemur – tarsi of leg I, Fig. 8: Basifemur – tarsi of leg II, Fig. 9: Basifemur – tarsi of leg III, Fig. 10: Leg IV.

from known species of the genus *Copidognathus* by the huge, pointed ventro-lateral lamella on telofemur I and AD with long, stout, spine-like frontal elongation.

C. subterraneus Bartsch and Iliffe, 1985 is the only species of *Copidognathus* known to possess a huge, pointed ventro-lateral lamella on telofemur I but its AD lacks a long spine-like frontal elongation. It is thus readily separated from *C. gitae*.

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REFERENCES

BARTSCH, I. & ILIFFE, T.M. (1985): The halacarid fauna (Halacaridae, Acari) of Bermuda Caves. *Stygologia 1:* 300-321.

RAO, G.C. (1970): On some interstitial fauna in the marine sands of Indian coast. The salt-water mite *Halacarus anomalus* Trouessart in the interstitial sands on Indian coast. *Curr. Sci. 39:* 504-507.

RAO, G.C. & GANAPATI, P.N. (1968): The interstitial fauna inhabiting the beach sands of Waltair coast *Proc. Natn. Inst. Sci. Ind. 34B* (2): 82-125.

SARMA, A.L.N. (1974a): Phytal fauna of *Caulerpa taxifolia* and C. *racemosa* off Visakhapatnam coast. *Indian J. Mar. Sc.* 3: 155-164.

SARMA, A.L.N. (1974b): The phytal fauna of *Sargassum* of Visakhapatnam Coast. *J. Mar. Bio. Ass. India. 16* (3): 741-755.

SARMA, A.L.N. (1974c): The phytal fauna of *Ulva fasciata* off Visakhapatnam Coast. *Proc. Ind. Acad. Sc. LXXX* Sec. B: 147-157.

SARMA, A.L.N. & GANAPATI, P.N. (1972): Faunal associations of algae in the intertidal region of Visakhapatnam. *Proc. Nat. Sci. Acad. India B: 38*: 380-396.

SARMA. A.L.N. & GANAPATI, P.N. (1975): Phytal fauna of the Visakhapatnam harbour buoys. Bulletin of the department of Marine Sciences. Univ. of Cochin. *VII*(2): 263-273.

REVIEWS

FRESH WATER INVERTEBRATES OF DHARWAD by C.S. Patil and B.Y.M. Gouder. pp. 144 (24.5 × 16 cm.) with 25 plates and many figures. Dharwad, 1989. Prasaranga, Karnatak University, Dharwad. Price Rs. 36, £6.00, $ 12.00.

Taxonomy is the cradle of biological sciences. While "modern" biologists, working with sophisticated instruments, may tend to look down on taxonomy as an old-fashioned branch of science, they are forced to turn to taxonomists for identifying the animal or plant they are working on.

It requires intensive specialisation to master just one group of animals, so one can imagine how much more difficult it would be to work on several phyla. Yet that is what limnologists, marine biologists and biological oceanographers have to cope with. The authors have valiantly attempted to do this in their book.

From the "cheap" academic appearance of the cover so similar to the plethora of text books and guides for college students, one might be led to believe that this book is one more such, but the contents will immediately bear it out to be different. However, the title of the book is misleading, as it covers only six invertebrate groups (Cladocera, Copepoda, Ostracoda, Rotifera, Insecta and Mollusca), leaving out Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemertea, Nematoda, Nematomorpha, Entoprocta, Annelida, Tardigrada and many major crustacean orders such as Anostraca, Notostraca, Conchostraca, Mysidacea, Isopoda, Amphipoda and Decapoda. A title such as "some fresh water invertebrates of Dharwad" would have been more appropriate and modest. Yet it must be admitted that the authors have plunged into their task with unbounded enthusiasm, as is obvious from a sentence in their preface, which reads, "The study of inland waters is multifaceted, kaleidoscopic, vexing, fascinating and fruitful."

Reading the first page and a half of the verbose Preface, one might be tempted to believe that the book deals with pollution, and not with a faunistic study. When, oh when, will our scientists resist the temptation of jumping on the bandwagon of environment?

"The lengthy preface, though it does not bear any relevance to what is written in the book, is purported to impress upon the readers how important the study of freshwater is." These are not the reviewer's remarks but those of the authors who, on second thoughts, seem to have realised the incongruity of their preface.

The aim of the book, as the authors emphasize, is to help the undergraduate student who is often discouraged by having to seek several hard-to-trace references before a taxonomic study can be undertaken. Therefore, their resume of earlier work done in India, and exhaustive list of references is of immense help. However, by no stretch of imagination can the list be said to "have covered all the previous literature on the taxonomy of the Indian forms", as is pompously stated in the foreword.

The authors have mentioned varieties of plankton nets such as Birge, Wisconsin, Juday etc., but they have not described them. Probably they have assumed that the reader is already conversant with them, from books such as Welch's 'Limnological Methods'. Similarly, only ranges (minimum and maximum) of physico-chemical parameters are given; these have no relevance to the aim of the book, but appear to have been included as the data was available from the thesis of one of the authors.

I shall not comment on the liberal use of the word 'the'; it is bad English but does not affect the technical meaning of the text, even though it does detract from smooth reading. So is the improper 'infront of' and 'Srilanka' used at many places, as well as the wrong placement or omission of commas and parentheses. And I fail to grasp the meaning of their sentence "Through water, many substances and cycles find their traffic" (p. viii). But, in view of their doctoral status, the authors should know that the abbreviation of 'species' (plural) is not sps. but spp., and that, while names of genera and species are written in italics, those of orders and families are not, and that a subgenus starts with a capital letter. At many places, the words Crustacea and Cladocera start without a capital letter.

All these slips can be taken in one's stride, but finally what 'browned' me off was the most slipshod and careless proofreading. If the authors had noticed

these mistakes in the proof, the lengthy (three-page) errata comprising 110 mistakes could easily have been avoided. Even after this, I could spot as many as 88 uncorrected errors. Normally, I would have listed the mistakes here, had they been few, but, to avoid embarrassment to the authors, the list will be sent to them, so that loose sheets of errata can be got printed and inserted in unsold copies of the book.

As it is, the limited area of the locations near Dharwad would preclude readers from buying the book, but had it been of the high standards set by Ward and Whipple (Freshwater Biology), Pennak (Freshwater invertebrates of the United States), Needham and Needham (A guide to the study of fresh water biology) abroad and by Tonapi (Fresh Water Animals of India – an ecological approach), limnologists would have been tempted to buy the present work. One can only hope that it will not be one of those, unhappily too frequent, flash-in-the-pan one-edition books that die a premature death, unlamented and unsung.

If I were asked to conclude in one sentence, my remarks would be: a work of extraordinarily high quality, the presentation of which leaves a lot to be desired.

B. F. CHHAPGAR

A MANUAL OF FRESHWATER ECOLOGY (AN ASPECT OF FISHERY ENVIRONMENT) by R. Santhanam, P. Velayutham and G. Jegatheesan. pp. ix + 134 (22 × 14 cm), with 101 illustrations. Delhi, 1989. Daya Publishing House. Price Rs. 130/-.

For college students and fishery workers in India, a number of excellent foreign books on limnology and methods of water analysis, such as by Welch, Wetzel *et al.,* Gotterman, etc. are available, supplemented by Odum, Edmonton (Ward & Whipple), Southwood, etc. for ecology and flora-fauna. These, however, are not easily available, and too costly for the average student. The present book, therefore, fulfills a long felt need.

An additional advantage of this book is that, while others are restricted to analysis of water and aquatic organisms, this one also includes soil analysis. However, the authors have left out an important part of soil analysis, viz. its character (whether the soil is clayey, loamy or sandy) and particle size distribution, by sieve analysis or sedimentary methods. These have an important bearing on aquaculture.

The authors have obviously taken a lot of pains to compile the book. Their writing is not only (on the whole) correct but also thorough. For example, while other books describe a Secchi disc and briefly state how it is to be used, here they stress that it should be lowered from the sunny side of the boat, and not in the early morning or evening, when the sun would be far inclined to the earth.

Books like the present one, of course, entail a compilation of methods, either from original research papers or from other sources. That the authors have resorted to copying verbatim from other books can be seen from at least two instances. Thus, on p. 65, in the description of pump and hose method, the text reads, "The pump may be used to suck sea water samples ...". Again, on p. 69, "... the net is held vertically and washed carefully with flowing sea water." (Note that the book is titled "A manual of *freshwater* ecology".)

A few other slips have crept in here and there. Despite careful re-reading, I could not make out the sense of the following sentence (on p. 18). "... and the precipitate is washed with warm distilled water until the filtrate shows no trace of chlorides which can be tested by adding a few drops of silver nitrate is formed during the addition of silvery nitrate solution to the sample."

In a book where many chemical formulae have to be printed, the typesetting needs extra caution. On pages 21 and 22, NO_2 – N and NO_3 – N are wrongly printed as No_2–N and No_3–N. Similarly, the electric charges on the two sides of the following formula (on p. 12) do not balance:

$CO_3^{2-} + H^+$ ----> HCO_3

apart from the mistakes (the formula reads

$CO_3^{2-} + H^+$ ----> HCo_3

Another slip which has often crept in is the substitution of 1 (one) for l (for litre), which may be seen in the text on p. 26 (PO_4-P/1) and p. 29 (100 µg/1), and in the subtitles on pp. 27 and 28.

Another irritating (grammatical) mistake is the use of the phrase "and to which is added" instead of "to which is added" on pp. 11 (twice), 18, 19, 20, 23, 25, 31, 37, 38, 45, 46, 47, 48, 49 and 50.

The authors advocate the use of khaki (misspelt "kaki" on p. 124) cloth in making a plankton net (p. 66). They are under the impression that khaki is a name for a sturdy cloth. Actually, khaki is a colour (of the army uniform), and drill or canvas cloth (of any colour) has to be used in plankton nets.

The authors are confused by the terms 'formaldehyde' and 'formalin'. Thus, on p. 70, they state, "One litre of 20% neutralised stock *formaldehyde* (italics mine) solution is prepared by diluting 200 ml of 40% *formaldehyde* (italics mine) solution with 800 ml of tap water ...". 20% formaldehyde solution can be obtained by diluting 40% formaldehyde (100% formalin) with an equal volume of water. To make 5% formalin, one has to dilute it eight times (40 divided by 8 equals 5), by diluting 200 ml formaldehyde with 1400 ml of water (to give a total of 1600 ml). Their formula (200 + 800 = 1000 ml) would dilute it five times, making it 8% formaline.

Similarly, on page 102, they state, "for preparing a 5% formaline solution of (sic) 5 ml of 100% formalin solution should be added to 25 ml of distilled water." This gives a dilution of six times (and not five), making it 6.6% formalin. To make 5% formalin, one should add 5 ml of formaldehyde to 35 ml of water.

The illustrations in the book are excellent and very clear, except for that of the inverted microscope (fig. 87 on p. 125), which is absolutely terrible.

Despite all the above, I would have given a hundred marks out of 100, had it not been for the extremely slipshod proofreading, which has completely marred the otherwise valuable informative contents. I could locate over 70 mistakes – most of them spelling. While, individually, they may be trivial, they do add up. It is about time Indian authors learnt to go through their proofs meticulously. As the errors are too many to be listed here, the authors will be furnished a copy of the same, so that loose errata sheets may be inserted in unsold copies of the book.

B. F. CHHAPGAR

MISCELLANEOUS NOTES

1. FEEDING ASSOCIATION OF THE LITTLE GREBE *PODICEPS RUFICOLLIS* (PALLAS) WITH DUCKS

The little grebe *Podiceps ruficollis* (Pallas) is known to associate with waterfowl for feeding, e.g. with coot *Fulica atra* (Ashmole *et al.* 1956), with shoveller *Anas clypeata* (King 1963), with Cape shoveller *Anas smithii* (Siegfried 1971), with feral domestic duck (Robson 1975) and with maccoa duck *Oxyura maccoa* (Burger and Berruti 1977). On three different occasions I have seen little grebes commensally feeding with shoveller, with pintail *Anas acuta,* and with pintail and wigeon *Anas penelope.*

On 28 November 1982, in the Dihaila jheel inside the Karera Bustard Sanctuary, Shivpuri district of Madhya Pradesh, I saw a little grebe continuously following a male shoveller for about 25 minutes. The depth of the water where the shoveller was feeding was about 20 cm and as it raked up the water by dabbling at the surface or by up-ending, the little grebe was seen to dive and pick up small prey items.

On 16 January 1988, in Lakh-Bahosi jheel in Farrukhabad district of Uttar Pradesh, at about 1130 hrs, I saw two little grebes attending four actively foraging male pintails. As soon as the pintails up-ended, the grebes would dive behind them. Once a grebe dived so close to a pintail that it was kicked by the latter's paddling feet. The grebe would dive only after the pintails had up-ended for feeding. Twice one of the grebes dived in the middle of three up-ended pintails. The average time spent inside the water by the grebes was 13.4 seconds (n=7, SD = ± 2.93). From the time I saw this association, it lasted for 15 minutes. The pintails were not bothered by the presence of grebes and no agonistic interaction was noticed. Only once did I see a grebe bringing something from the water and swallowing it. Most of the time the food was possibly eaten while inside the water.

The third sighting of this commensalism was on 18 January 1988 at the Berkhera jheel in the Karera Bustard Sanctuary. At 1705 hrs I saw five little grebes following 10 male pintails and two male wigeons. In this case also, the grebes would dive behind the ducks when the latter had up-ended to feed on the submerged vegetation. This association was seen only for 4-5 minutes but it must have been going on for a longer time.

The grebes followed the ducks closely. I am not sure whether each grebe was associated with one particular individual duck or it was a random association. sometimes three or four grebes would dive simultaneously and come out in unexpected spots (but within 2 m of the foraging ducks). After emerging, the grebe would scurry towards the nearest duck. As there were five grebes close together, diving in and out of the water, I could not correctly note the time each grebe spent inside the water because there was no way to identify different individuals.

Though I could not find out how far the grebes were successful in procuring food, in all the three cases observed, they were certainly benefiting from their commensal association with ducks. Such types of feeding association are known in other species of grebes also, for example, horned grebe *Podiceps auritus* attending surf scoter *Melanitta perspicillata,* and least grebe *P. dominicus* with domestic mallards *Anas platyrhynchos* (Paulson 1969); blackthroated grebe *P. novaehollandiae* with coot and dusky gallinule *Gallinula tenebrosa* (Hobbs 1958); pied-billed grebe *Podilymbus podiceps* with Louisiana heron *Hydranassa tricolor* and with snowy egret *Leucophoyx thula* (Mueller *et al.* 1972), so it is not an uncommon occurrence. However, as far as I know it has not been studied in detail. It would be interesting for Indian ornithologists to study this on our resident little grebe.

March 1, 1990 ASAD R. RAHMANI

REFERENCES

Ashmole, N.P., Brown, R.G. & Tinbergen, N. (1956): Feeding association between coot and little grebe. *Brit. Birds* 49: 501.

Burger, A.E. & Berruti, A. (1977): Dabchicks, *Podiceps*

ruficollis, feeding in association with Maccoa ducks *Oxyura maccoa*. *Ostrich 48:* 47.

HOBBS, J.N. (1958): Some notes on grebes. *Emu 58:* 129-132.

KING, B. (1963): Feeding association between shovellers and little grebes. *Wildfowl 14:* 172.

MUELLER, H.C., BIBEN, M.G. & SEARS, H.F. (1972): Feeding interactions between Pied-billed grebes and herons. *Auk 89:* 190.

PAULSON, D.R. (1969): Commensal feeding in grebes. *Auk 86*: 759.

ROBSON, R.W. (1975): Feeding association between little grebes and feral domestic ducks. *Brit. Birds 68:* 293-294.

SIEGFRIED, W.R. (1971): Feeding association between *Podiceps ruficollis* and *Anas smithii*. *Ibis 113*: 236-238.

2. OCCURRENCE OF BLACKNECKED GREBE *PODICEPS NIGRICOLLIS* BREHM, LITTLE GREBE *P. RUFICOLLIS* (PALLAS) AND GOOSANDER *MERGUS MERGANSER* LINN. IN WEST SIKKIM

Khechiperi lake (1850 m) in west Sikkim is a small, oval, freshwater mountain lake roughly 1 km in diameter, surrounded by forested slopes. It lies 13 km off the road to Yoksum, the base camp for trekkers going to Dzongri or Goecha La, and is both a place of worship and a popular picnic spot because of its scenic beauty.

Migratory ducks have been regularly using the lake and during this year's Asian Waterfowl Count (15 January 1989) we counted 40 *Mergus merganser*, both male and female in full breeding plumage and 6 grebes which at first sight looked like 3 pairs of smaller, duller 'females' and bigger, brighter 'males'. On referring to the PICTORIAL GUIDE (Ali, S. and Ripley, S.D. 1983) and the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983), the 'females' were identified as dabchicks or little grebes *Podiceps ruficollis* and the 'males' as blacknecked grebes *P. nigricollis* by their dark heads, silvery cheek patches and very conspicuous silvery grey flanks.

Both species were swimming together and at a little distance from the mergansers, which were feeding actively by diving suddenly into the water together, leaving just 4 to 6 individuals on the surface. We spent one hour (1100-1200 hrs) combing the lake, counting and re-counting until we were sure of the number of birds. There was a *puja* going on on the bank of the lake but this did not seem to disturb the birds which were moving around *c.* 300 m away, nearer the opposite shore of the lake.

In November-December 1988, a party of picnickers reported over a hundred of the 'black-and-white ducks' or mergansers which they said were quite 'tame' and swimming 20-30 m from them. A month earlier, during a casual visit to the lake in October 1988 on my way to Yoksum, I had seen just 2 dabchicks on the otherwise empty lake. Apparently the mergansers and blacknecked grebes are transient migrants. That the dabchicks are year-round residents was confirmed by the local wildlife guards.

The merganser has been described as "The only resident duck which also possibly breeds....at high elevations...."(BIRDS OF SIKKIM, Ali, S. 1981), "....possibly in North Sikkim...." (HANDBOOK *1:* 204-205). The dabchick has been described as "Common throughout the Indian subcontinent, east to Assam and Manipur, south into Ceylon from the plains to *c.* 1800 m altitude (in Kashmir)," (HANDBOOK 1: 7). Our observations are thus both interesting records for Sikkim.

No such data are available on the blacknecked grebe, the nearest record being in Nepal by R.L. Fleming (1957, *Fieldiana, Zool. 41(1):* 48) (HANDBOOK *1*: 5). This bird, with the status of uncommon winter visitor, breeding extralimitally in the Palaearctic region from Europe to China and Japan, south to Turkestan and whose migratory status is not known, seems to be a new record for Sikkim, probably a winter migrant from China. Whether it is a rare visitor needs to be confirmed.

July 29, 1989 USHA GANGULI-LACHUNGPA

3. NESTING OF THE POND HERON *ARDEOLA GRAYII* (SYKES) ON *EUCALYPTUS* TREES

Nests of the pond heron *Ardeola grayii* (Sykes) as reported in HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983) are generally seen on trees like *Tamarindus indica, Mangifera indica, Acacia arabica, Salix, Tamarix* and many mangroves. I documented 26 nests of *Ardeola grayii* during April to June 1988 on *Eucalyptus* trees planted at Kananpendari, Bilaspur, Madhya Pradesh. These nests were built on three *Eucalyptus* trees growing 200 m away from the village water pond. The nests were located at heights of 10 to 12 m on trees *c.* 13 to 14 m tall. Nests were made using the dried twigs of *Eucalyptus* L. Her., *Azadirachta indica* A. Juss., *Butea monosperma* (Lamk.) Taub., *Dendrocalamus strictus* Nees, *Syzygium cuminii* (Linn.) Skeels, and twigs belonging to at least five other unidentified species. Besides this, in one nest stubble of *Sorghum vulgare* and *Cajanus cajan* were also recorded. The nesting in *Eucalyptus* is unusual and has not been recorded before.

July 29, 1989 DEEP NARAYAN PANDEY

4. RECORDS OF THE REDLEGGED FALCON *FALCO VESPERTINUS AMURENSIS* IN GUJARAT

From 14 to 16 January 1989, we participated in the annual Asian Midwinter Waterfowl census and visited waterbodies in the southern parts of the Saurashtra region of Gujarat. On the last morning, at about 1015 hrs, we were crossing open countryside north-east of the coastal town of Madhavpur on the highway connecting the port cities of Porbandar and Veraval. This region, called *ghed,* is a low lying area that gets inundated during the monsoon. It was now dry and had been completely cultivated with gram *Cicer arietinum,* wheat *Triticum aestivum* and a few other minor crops.

A group of eight falcons, very much like the kestrel *Falco tinnunculus,* were hawking insects above the crops and then resting along an electricity line and posts. Since this species does not normally feed in groups, we stopped to take a better look at them. We were very close to a few of the resting birds, the morning light was favourable and the birds were not unduly disturbed by our presence. After a few minutes of observation, the group lifted off together and flew south, out of view in the direction of the coast about 5 km away. Two of the birds were immediately identified as the kestrel. The other six were slightly smaller and differently coloured. Two of these had slate grey upperparts including the head and nape, white forehead and a very clear moustachial stripe bordering the large white cheek. The underside was white with black streaks on the breast and upper belly. The most outstanding feature was the pinkish-orange legs, bill and cere. Three of the birds had brown upperparts and were heavily marked below; obviously these were immatures of the same species. The sixth bird was perched on an electric post partially hidden from view but was also of the same species.

None of the birds illustrated in the field guides (Heinzel *et al.* 1979, Peterson *et al.* 1983) that we had in hand, appeared to match our birds. Only the red legs suggested that this species was the redlegged falcon. Subsequently we consulted other books. Brown and Amadon (1986) in their Plate 148 illustrate beautifully the male and female of the two races of the redlegged falcon: *Falco vespertinus vespertinus,* the western race, and *F. v. amurensis,* the eastern race. The illustration of the female of the eastern race perfectly resembled two of the birds that we had observed. Digby (in Cade 1982, Plate 25) also illustrates the female of the eastern race as clearly different from that of the western race. In conclusion, the birds observed by us belonged to the eastern race of the redlegged falcon.

Cade (1982) considers the two races of the redlegged falcon as separate species on the basis of behavioural and other differences. In India, the only race so far recorded, either breeding or as a passage migrant, is the eastern race (Ali and

Ripley 1983a) even though the illustration by Henry (in Ali and Ripley 1983a, Plate 18) depicts the female of the western race, as the crown is painted brown. Similarly, Dick (in Ali and Ripley 1983b, Plates 29 and 30) has also illustrated the female of the western race, both in the sitting posture and in flight as viewed from underneath; the white tip on the tail has been shown, whereas the eastern race appears to lack this.

One of us (P.P.) had previously seen this species in late February 1984, when he had a quick glimpse of a male in the Adhodiya nullah in the Gir Wildlife Sanctuary, also situated in southern Saurashtra. The bird, immediately identified as a male by the distinctive dark general coloration and dark red abdomen, landed on a branch of a tree with three other birds, but they were soon chased away by house crows.

From the few records in India, this rare falcon is understood to be a passage migrant from the main breeding grounds in China to the wintering grounds in east and south Africa, though a few birds breed in Assam in India. The birds have been seen in Karnataka on the west coast of India in November and December on their south-west migration across the Indian Ocean to east Africa. The northern-most record on the west coast so far has been near Bombay (Ali and Ripley 1983a), and there are no published records of this species from Gujarat. The observations reported here, therefore, constitute a northward extension of this species on the west coast of India and suggest that the redlegged falcon may be using more of our western coastline on their migration than was previously known.

On our survey, we were fortunate to have Narendrasinh Jhala, Rishad Pravez and Parimal Joshi with us. We are grateful to Prof. R.M. Naik for his comments on the manuscript and to Shrivrajkumar Khachar for permitting us the use of his excellent library.

TAEJ MUNDKUR
PRADEEP PANDYA
April 27, 1989

REFERENCES

Ali, S. & Ripley, S.D. (1983a) : Handbook of the Birds of India and Pakistan. Compact edition. Oxford University Press, New Delhi.

Ali, S. & Ripley, S.D. (1983b) : A Pictorial Guide to the Birds of the Indian subcontinent. Bombay Natural History Society, Bombay.

Brown, L. & Amadon, D. (1968) : Eagles, Hawks and Falcons of the World. Volume II. Country Life Books, London.

Cade, T.J. (1982) : The Falcons of the world. Cornell University Press, Ithaca.

Heinzel, H., Fitter, R., & Parslow, J. (1979) : The birds of Britain and Europe. Fourth edition. Collins, London.

Peterson, R., Mountford, G. & Hollom, P.A.D. (1983) : A Field Guide to the Birds of Britain and Europe. Fourth Edition. Collins, London.

5. ADDITION TO THE DIETARY OF WHITEBREASTED WATERHEN *AMAURORNIS PHOENICURUS* (PENNANT)

The whitebreasted waterhen *Amaurornis phoenicurus* is common in the reed-covered marshy wastelands, stagnant water bodies and along the river banks in Tiruchirapalli, Tamil Nadu. THE BOOK OF INDIAN BIRDS (Ali, S. 1979) states that its food includes "Insects, worms, molluscs, grain and shoots of paddy and marsh plants". At about 0630 hrs on 29 April 1989 we observed a bird of the species emerge from among the reeds on a bank of Kudamuruti, a branch of the Uyyakondan canal of the Cauvery, pick up a fallen fruit of korkapilly (*Pithecolobium dulce*), isolate the white caruncle from the seed and eat it, breaking it to bits by pecking at it several times. Whether or not this forms a common food item for the bird is not known.

A. RELTON
A. ALAGAPPA MOSES
H. DANIEL WESLEY
June 15, 1989

6. THE WATERCOCK *GALLICREX CINEREA* IN KUTTANADU, KERALA

Kuttanadu, the rice bowl of Kerala, lies in the Alleppey and Kottayam districts of central Kerala, in the delta formed by the three rivers Pampa, Achencoil and Manimala, around the Vembanadu lake. The extensive paddy fields of Kuttanadu were once part of different lakes and lie below the main sea level. Farmers have constructed bunds around these fields and pump the water out for paddy cultivation.

The watercock *Gallicrex cinerea* (local name Neiykozhi) is a seasonal visitor to Kuttanadu, coming in large numbers and staying for two to three months between November and March. This is the season during which the paddy starts ripening. The birds are largely immatures. Even mature birds cannot be sexually distinguished since they are in non-breeding plumage.

It is not known from where these birds arrive; it may be from the north (Assam and Bengal). They come in at night, and during the day remain silent in the paddy fields in temporary day nests constructed with paddy. They are crepuscular. Rarely, they are seen flying slightly above the paddy for short distances.

Since they are very shy, they are never flushed even when the field is disturbed. Instead they skulk and move silently to another area. Bird trappers use this to catch the birds easily. They stretch long nylon nets along the border of the field, then from the other end drive the birds towards the net, where they are trapped en masse. The birds are highly priced since their flesh is considered tasty. In the season, hundreds can be found on sale in the markets of Edathua, Changanacherry and Alleppey and in other parts of Kuttanadu like Kainakary, Kidangara, Pulinkunnu, Muttar etc. A kilogram of live bird (i.e. about 3-4 birds) costs Rs. 25 to 35 in the season.

The birds face severe threat in Kuttanadu. Each year thousands of them are caught and killed. Habitat destruction is another major problem. Use of chemical fertilisers and pesticides have made the fields unsuitable for the birds. It has been noticed that they do not rest in fields where systemic poisons like Furadan are applied. The change in the season of paddy cultivation has also affected them. As a result the number of these birds is decreasing each year. This is no doubt that the watercock would become locally extinct, if they continue to be killed at the present rate.

June 20, 1989 J. G. RAY

7. SIGHTING OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* VIGORS NEAR PUNE, MAHARASHTRA

On 17 March 1986, I visited Jejuri, a religious place about 45 km south-east of Pune via Saswad. At about 1230 hrs I was wandering over the fields around the town when I saw a pair of great Indian bustard *Ardeotis nigriceps* under a half-cut tamarind tree. Whether both the birds were males or females or whether they were of different sexes, I could not differentiate. One bird was chasing the other. My appearance on the scene probably disturbed them, and they slowly started moving away from me and ultimately flew away.

On 23 March, Tejas Gole and P. Gogate visited the area and found the birds around the same area, about 250 m away from where I had first sighted them. One of the birds was photographed. This is probably the only sight record of the bustard in Pune district during the last two or three decades.

August 2, 1989 SANJEEV B. NALAVADE

8. BREEDING OF CASPIAN TERN *HYDROPROGNE CASPIA* IN THE LITTLE RANN OF KUTCH, GUJARAT

While going through the Little Rann of Kutch Sanctuary in Gujarat on 23 December 1988, we were told by the staff of the sanctuary who were accompanying us, that they had come across a site

where flamingos had bred. They had seen eggshells and some dead chicks. This was an area on the edge of the Little Rann to the west of the flooded area of the Rann north of Pung Bet (Island). Approach to the area required a long circuit because the area was till recently an island which had been surrounded by water in this flooded part of the Little Rann. The water had recently receded, but the breeding of the birds in question must have taken place when the area was an island. We found a number of scraped shallow hollows in which fragments of spotted eggshells were lying. There was also one shrivelled up carcass of a chick, but it was beyond recognition. This was collected by the sanctuary staff. I collected the most complete remaining pieces of the eggshells. The nests were scattered about, some in clusters in which nests were 1 to 4 m apart. As sunset was approaching and we were pressed for time I could not make a complete survey of the nesting site. It was, however, obvious that the eggs did not belong to flamingos. There were no earthen mounds in the vicinity.

I gave the eggshells to Taej Mundkur who, after comparing the shells with the specimens from other terns and gulls in the BNHS collection, came to the firm conclusion that these eggs were of the Caspian tern *Hydroprogne caspia*. This may be the first record of breeding of this species in India, though it has been known to breed in Pakistan.

August 4, 1989 M.K. RANJITSINH

9. OCCURRENCE OF THE EUROPEAN NIGHTJAR *CAPRIMULGUS EUROPAEUS* LINN. IN KARERA BUSTARD SANCTUARY, MADHYA PRADESH

On 12 November 1985 when I was doing bird banding in Karera Bustard Sanctuary, Madhya Pradesh, the trappers brought a nightjar along with some waterbirds caught during the previous night. The three outer primaries with white spot in the middle and white tipped outer two pairs of rectrices confirmed it as a European nightjar *Caprimulgus europaeus*. The measurements of the bird were as follows:

Wing 175 mm, Bill 19 mm from skull, 9 mm from feather, Tarsus 21 mm, Tail 111 mm, Weight 54 g, Sex male.

Moult: The wing was with suspended moult, having two outer primaries worn out considerably. But the rest were freshly formed. The tail had all freshly moulted feathers.

The European nightjar is a summer visitor and passage migrant to Pakistan, and is fairly common and abundant as a transient on autumn passage (*c.* September) in southern Makran, Sind, and Kutch which lie on the easternmost fringe of the known migration route from Afghanistan, N.W. Pakistan etc., over Arabia to its winter quarters in Africa. The bird is rare in Sind in spring and apparently absent in Kutch. Stragglers have been recorded in Jodhpur (Rajasthan) and Bombay in October, and Gorakhpur (Uttar Pradesh) in January (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S. D. 1983). There is no previous record of the European nightjar in Madhya Pradesh; this ringing record of this species confirms its occurrence in that state.

I am thankful to Eric D'Cunha for helping me in identifying the nightjar.

February 20, 1990 V. NATARAJAN

10. FOOD SELECTION BY SPANGLED DRONGO *DICRURUS HOTTENTOTTUS* (LINN.) AND CHOICE OF TREES FOR AFFORESTATION

The spangled drongo *Dicrurus hottentottus* is a flower-nectar feeding bird. An exhaustive list of trees on which the bird feeds is not available. I have studied the food selection by the bird at Dehra Dun (30°19' N, 78°04' E) during July 1988 to August 1989 and the trees used for the purpose are listed in Table 1.

This information can be utilized in the choice of

TABLE 1
FOOD SELECTION BY SPANGLED DRONGO

Flowering tree	Degree of use	Flowering tree	Degree of use
Acrocarpus fraxinifolius Wight & Arn.	C	*Erythrina indica* Lamk.	F
Adina cordifolia Hook. f.	C	*Eucalyptus* L' Her.	R
Anthocephalus cadamba Miq.	C	*Grevillea robusta* A. Cunn.	C
Bauhinia variegata L.	C	*Jacaranda mimosifolia* D. Don	R
Bombax ceiba L.	F	*Lagerstroemia speciosa* L. Pers.	R
Butea monosperma (Lamk.) Taub.	F	*Parkia biglandulosa* W. & A.	E
Callistemon viminalis Cheel	R	*Peltophorum pterocarpum* (DC.) Backer ex K. Heyne	C
Cassia fistula L.	C	*Saraca asoka* Roxb.	C
Cassia javanica L.	C	*Spathodea campanulata* Beauv.	C
Chorisia speciosa St. Hill	F		
Cochlospermum gossypium DC.	R		
Dalbergia sissoo Roxb.	R		
Delonix regia (Boj.) Raf.	F		

F = Frequent (feeding recorded during 75% to 100% of observations); C = Common (during 25% to 74% of observations); R = Rare (during less than 25% of observations)

species for recreational forestry. Depending upon the degree to which a management plan favours the nectar-feeding birds, suitable tree species can be selected for plantation. Alternatively, the required proportion of flowering trees can be retained in the natural forests.

August 23, 1989 DEEP NARAYAN PANDEY

11. INTENSE MOBBING BY A BLACK DRONGO *DICRURUS MACROCERCUS*

Rahmani and D'Silva's observation of a drongo landing on a flying short-toed eagle *Circaetus gallicus* (*JBNHS 82 (3):* 657) reminds me of a similar incident. In the summer of 1974 I studied nesting black-eared kites *Milvus migrans lineatus* on Stonecutters Island, Victoria Harbour, Hong Kong. On one occasion I saw a juvenile kite in gliding flight when an adult black drongo *Dicrurus (adsimilis) macrocercus* flew after it. The drongo stood briefly on the back of the kite and pecked it several times before flying off.

Nash and Nash (*Kukila 2:* 7) also have reported a greater racket-tailed drongo *Dicrurus paradiseus* standing on the back of a flying great hornbill *Buceros bicornis*.

August 16, 1989 DAVID S. MELVILLE

12. NESTING HABITAT SELECTION BY THE PIED MYNA *STURNUS CONTRA* LINN.

A list of the trees utilised as nest sites by the pied myna *Sturnus contra* Linn. is not available. Availability of nesting sites determines the survival of birds.

Between July 1983 and June 1988 I visited the states of Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, Himachal Pradesh, Goa and the Union Territories of Pondicherry and Delhi, and information on the nesting sites was collected during these visits. The list of tree species used for the purpose is given below, with the number of nests recorded given in parentheses.

Acacia arabica Willd. (7), *Adina cordifolia* Hook. f. (2), *Albizzia lebbek* Benth. (9), *Artocarpus integrifolia* L. (22), *Bauhinia variegata* L. (17), *Borassus flabellifer* L. (1), *Cassia fistula* L. (16), *Cassia javanica* L. (24), *Cordia myxa* Roxb. (3), *Chorisia speciosa* St. Hill (1), *Dalbergia sissoo* Roxb. (10), *Delonix regia* (Boj.) Raf. (13), *Emblica*

officinalis Gaertn. (2), *Erythrina indica* Lamk. (1), *Eucalyptus* L'Her. (3), *Ficus benghalensis* L. (15), *Ficus religiosa* L. (7), *Lagerstroemia speciosa* (L.) Pers. (11), *Mangifera indica* L. (12), *Melia azedarach* L. (2), *Morus alba* L. (1), *Peltophorum pterocarpum* (DC.) Backer ex K. Heyne (15), *Pithecellobium dulce* (Roxb.) Benth. (3), *Psidium guajava* L. (6), *Syzygium cuminii* (L.) Skeels (9), *Tamarindus indica* L. (7), *Zizyphus mauritiana* Lamk. (8).

It is hoped that this information would be of use in the management of bird life in natural and multiple use plantation forest in the country.

August 1, 1989 DEEP NARAYAN PANDEY

13. DISTRIBUTION OF ORANGEBILLED JUNGLE MYNA *ACRIDOTHERES JAVANICUS* CABANIS IN NORTH-EAST INDIA

(With a text-figure)

The orangebilled jungle myna *Acridotheres javanicus* is a handsome bird with an almost jet black body, sharply contrasting deep yellow bill (wholly) and prominent white wing-patch. It has an equally prominent tuft of erect black feathers on the base of the bill, which are longer than in the common jungle myna *A. fuscus*. Sexes are alike.

According to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983) it is distributed in Nagaland, Manipur, Tripura (?), Mizoram, Chittagong hill tracts of Bangladesh and also Burma and affects open country with elephant grass, semi-cultivation and village environs, from the foothills up to *c.* 1300 m.

During a field survey in different parts of north-east India, I came across *A. javanicus* on several occasions, sometimes in areas where it has not previously been recorded.

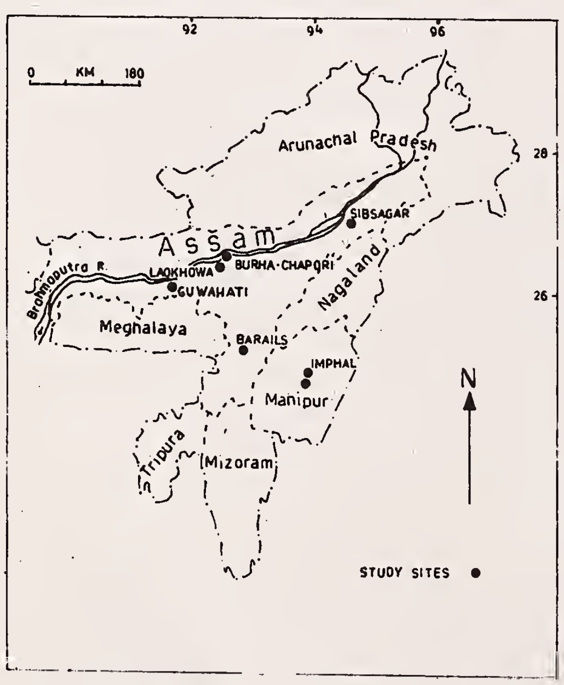


Fig. 1. Recent sightings of *Acridotheres javanicus*.

On 18 February 1986 at Dimbruchara, near Harangajao in North Cachar Hills district, I saw two deep black birds with yellow bill and prominent white patch on the wings. I only recently identified them as *A. javanicus*. Dimbruchara is a *taungiya* village located inside Barail reserved forest (RF).

During my stay at Sibsagar in Upper Assam, I often came across many dark jungle mynas. In Upper Assam the jungle myna is represented by its dark-phased subspecies *A. f. fumidus*. When wet, after rain or a bath, this dark-phased myna looks almost black for some time. So there remains a lot of confusion in the identification of *A. javanicus*, unless of course observed from close range and in detail. It was on 14 February 1988 that for the first time I observed a pair of *A. javanicus*, authentically identified from close range. The birds were feeding on the flowers of simul *Salmalia malabarica* behind PWD office/quarters near Dak Bungalow at the northern end of Sibsagar town. Later on, I observed them on the simul trees behind the Dak Bungalow where I also photographed one bird.

In April 1988 I paid a short visit to Manipur. At Imphal, the state capital, I was rather surprised to see that *A. javanicus* is the commonest myna, while the common myna *A. tristis* is much rarer. It has virtually replaced the latter with equal adaptability by colonising houses, roof-tops, gardens, etc. It is mostly seen in pairs and also in small parties. About a dozen birds were seen on the way to Moirang on cultivated fields.

The occurrence of *A. javanicus* in Manipur is already recorded. Since North Cachar hills and Sibsagar are adjacent to Manipur and Nagaland respectively, its sighting in these two districts was not

entirely unexpected.

On 20 January 1989 I saw two *A. javanicus* perched on top of a rain tree *Enterolobium saman* near my office on Zoo Road in the heart of Guwahati city. In fact, I observed the birds through my window. It was a rare sight, with four more species of mynas visible from the same window at the same time (1500 hrs). Some common and jungle mynas were also on the same tree. One bank myna *A. ginginianus* flew past the tree, while a few pied mynas *Sturnus contra* were seen just below the tree. Thereafter, perhaps the same pair was seen on some subsequent days also.

On 17 March 1989, I saw a pair feeding on the flowers of simul near the Forest Inspection Bungalow in the Burha-Chapori RF of Sonitpur district. Burha-Chapori is a *char* or sandy island/tract of the Brahmaputra river. On the same tree in Burha-Chapori it was again seen on 18 March. On the same day a small flock was seen among bushes and thickets in Laokhowa Wildlife Sanctuary of Nagaon district. Laokhowa is adjacent to Burha-Chapori and in both the areas elephant grass with patches of woodlands form the main habitat type.

In Manipur it can be assumed to be a resident, but in the case of Assam, especially the Brahmaputra valley localities (Sibsagar, Guwahati and Burha-Chapori- Laokhowa), its status is still not satisfactorily known. All the sightings recorded by me were between January and March.

April 20, 1989 ANWARUDDIN CHOUDHURY

14. COMMON MYNA *ACRIDOTHERES TRISTIS* (LINN.) FISHING

On 28 June 1989 at 0600 hrs I sat in a hide overlooking a couple of pools in the Sigurhalla, a jungle stream that courses through the Sigur Reserve in the Nilgiris district in Tamil Nadu. This once perennial stream now remains dry most of the year. The shallow pool immediately below me was fast drying up. Carp fingerlings 2 to 6 cm long were struggling for survival. A common kingfisher *Alcedo atthis*, observing me, departed. Along came a common myna *Acridotheres tristis* and, observing the surfacing fish, it waded into the shallows and picked up a 4 cm long live carp, flew with it to a strip of grass some 10 m away and proceeded to eat it. It did not swallow the fish whole, kingfisher-fashion, but tore off pieces and gulped them down. Another common myna joined in and after each had killed and partially eaten three fishes, a quarrel ensued and put an end to the fishing. The following morning also seemingly the same two birds came and fished. But as the quarrel started soon after, they left abruptly. That evening one of the birds came and picked up a dead fish and ate some of it. Besides these two, other common mynas were observed in the area, but they did not take part in the fishing.

I have observed common mynas fishing in the Sigurhalla previously also. On each of these occasions the pursuit was not confined to an odd pair, but was in the nature of a general expedition.

August 8, 1989 E.R.C. DAVIDAR

15. YELLOWBROWED BULBUL *HYPSIPETES INDICUS* (JERDON) IN THE EASTERN GHATS

On a field trip to Mamandur forests in the Chitoor district of Andhra Pradesh (14 km from Renigunta) between 1 and 3 January 1988, I came across the yellowbrowed bulbul *Hypsipetes indicus*. We were on a trek towards Tumru-kona and were about 4-5 km from the Cudappah Road and in thick forest. The vegetation was particularly thick at the spot where I noticed the bird, perhaps as a result of the stream flowing close by. I am quite familiar with the double call notes of this species and this was how I first registered its presence. I heard the calls at least 3-4 times. Later, I noticed a couple of birds in flight; the encounter was brief and sudden. As I had limited time at my disposal, I could not investigate further.

The HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1983) says that the yellowbrowed bulbul is distributed in the evergreen biotope in the Western Ghats south of Belgaum and Goa and in Sri Lanka. It is said to be most common above 900 m although occasionally seen near sea

level. There do not appear to be any reports of this species outside this range, particularly in the Eastern Ghats. In this context, it is quite interesting to find a (relict?) population of this species in an isolated pocket in the Eastern Ghats.

S.A. Hussain (pers. comm. 1989) also saw yellowbrowed bulbuls in the Tirupati hills, thereby confirming my earlier sight record. I am grateful to him for encouraging me to write this note.

July 15, 1989 V. SANTHARAM

16. AGGRESSIVE BEHAVIOUR OF JUNGLE BABBLERS *TURDOIDES STRIATUS* (DUMONT) TOWARDS A SNAKE

At about 1500 hrs one afternoon during March 1989 we were awakened from our slumber by the agitated calls of jungle babblers *Turdoides striatus* at our residence in Malaparamba at Calicut. When we looked out through the window we saw four babblers attacking a small sized snake on the ground. When we came out for a closer look, the babblers flew away. The snake was unable to move properly and appeared to be in great distress; we ended its misery by killing it. When we examined it we found that most of the peck marks were in the head region and both the eyes were damaged. The snake was about 50 cm long and probably was a striped keelback *Amphiesma stolata.* The babblers were regular visitors to our residence but we do not know whether they had a nest nearby, which was the reason for their aggressive behaviour. We presume that this type of behaviour has not been reported earlier for jungle babblers. However, Johnsingh *et al.* (*JBNHS 79*: 503-511) reported that a group of whiteheaded babblers *T. affinis* lost interest in a 2 m active snake after mobbing it for four minutes.

S. DEVASAHAYAM
June 24, 1989 ANITA DEVASAHAYAM

17. PROBABLE SIGHTING OF PLAINBACKED MOUNTAIN THRUSH *ZOOTHERA MOLLISSIMA* (BLYTH) IN BANDHAVGARH NATIONAL PARK, MADHYA PRADESH

Bandhavgarh National Park is located in Shahdol District of Madhya Pradesh (23°30' to 23°48' N and 80°46'45" to 81°11' 36" E). It lies within the drainage area of the Son river, a southern tributary of the Ganga.

On 8 February 1987, while walking along a hill-slope covered with thick bamboo *Dendrocalamus strictus* my attention was attracted by some movement in the bamboo, the source of which was a thrush sitting fairly low on some fallen bamboo. It was positioned sideways on to me and was in clear view. It was about the size of Tickell's thrush *Turdus unicolor,* olive brown above; flanks heavily barred; chin and throat speckled to almost side of the face. Short eyebrow, just a hint of a wing bar, though I could not be sure of this. Bill dark brown and legs of same colour. After a while it flew up to another branch with its back turned towards me, flicking its tail up and then slowly lowering it.

On consulting the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali, S. and Ripley, S.D. 1968-74), the closest I could get to an identification was the plainbacked mountain thrush *Zoothera mollissima* or the longtailed mountain thrush *Zoothera dixoni.* They are mentioned in the text as being confusingly alike, with the most conspicuous distinguishing feature between them being the whitish wing-bars present in the latter, the former having pale-tipped wing-coverts considered inconspicuous. This bird did not have conspicuous wing-bars.

On 18 January 1988 I saw a similar bird, again on a hill-slope covered with mixed forest and bamboo. This time it was on the ground facing me and I could see the "crescentic spots" mentioned in the HANDBOOK on breast and belly, but no wing-bars.

On 18 November 1988, in company with Jack Poll, an experienced birdwatcher, and Dinesh Thapa, I saw this bird again at a place called Shesh Shayya where the vegetation is very moist and thick. It had

responded to a 'pishing' call made by Poll and flew up to an exposed branch of a gular (*Ficus glomerata*), where it remained clearly visible for about two minutes. Description from my notes is: "Olive brown above, no wing-bars. Buff eye-ring. Brown scaly marks on underparts but not on lower abdomen. Unmarked stripe of dirty white down chin. Bill brown, yellowish at base." All three of us agreed on this description. This corresponds with the description by Ali and Ripley for *Zoothera mollissima*. Unfortunately, we were unable to see it well enough in flight to note the prominent wing-patch. I saw this bird again on 6 February 1989 in a kasai tree (*Bridelia retusa*) in a mixed forest close to where I had seen it the last time.

Bandhavgarh is well outside the range ascribed by Ali and Ripley to either the western (*Z. m. whiteheadi*) or the eastern (*Z. m. mollissima*) races. However, I am reasonably certain that this is *Zoothera mollissima*, although it must be noted that the habitat that I saw it in was somewhat different in every instance to that described for the eastern race by Ali and Ripley which, to quote, "In winter affects open bush country about fallow cultivation on hill-sides and stream valleys, and along mule paths." If this is a correct identification than it would indicate that *Zoothera mollissima* is a regular visitor to Bandhavgarh in small numbers.

August 4, 1989 HASHIM N. TYABJI

18. FLIES FORMING A POSSIBLE FOOD SUPPLY FOR YOUNG HOUSE SPARROWS *PASSER DOMESTICUS* (LINN.)

On 18 February 1989 at Jhansi, Uttar Pradesh, I was sitting in a room that was crawling with flies, with scores of them flying around the glass panes of the windows.

After some time I noticed that a male and female house sparrow *Passer domesticus* were entering the room alternately and heading straight for the window to pick off the flies there. This they did by alighting on the window sill and hopping about or fluttering into the air after the flies, occasionally indulging in highly acrobatic chases of individual insects. After catching a gullet-full, they would fly off.

On two occasions I managed to make an accurate count of the number of flies taken – both times by the male – and they were 6 and 8. I could not get an accurate count for the female.

Since all the doors and windows were closed, the birds were entering and exiting by squeezing through the gap between one of the doors and the floor. They were flying a regular relay route, with the longest gap without either bird in the room being about 2 minutes.

Presumably the birds were parents catching the flies to feed their young, although I could not locate the nest. But it was interesting to see how the birds had located a rich source of food which they managed to exploit in spite of closed doors and windows. I had neither earlier seen, nor read about, sparrows taking flies.

August 4, 1989 HASHIM N. TYABJI

19. NESTS OF BAYA WEAVER BIRDS *PLOCEUS PHILIPPINUS* AND WINTERING ARTHROPODS

A large number of completed and half built nests of baya weaver birds *Ploceus philippinus* were collected from October 1988 to March 1989 from many localities in Alwar district, Rajasthan, to study the arthropods, which winter in these nests. Various types of spiders and insects were collected from the nests, as detailed below.

Spiders – *Plexippus paykullii* (Family Salticidae), *Marpissa* spp. (Family Salticidae), *Sparassus* spp. (Family Sparassidae), *Scytodes* spp. (Family Scytodidae). Bugs – *Dysdercus cingulatus* (Family Pyrrhocoridae).

Many spiders were seen with eggs and spiderlings with them. Many nests contained more than one type of spider. Bugs and spiders were sometimes seen together in the same nest.

All the collected nests were scrutinised and it was found that the nest ceiling is the most preferred

place where these arthropods take shelter during the winter, probably because it is better insulated than other parts of the nest, and is thus helpful for thermoregulation in these cold blooded animals. This 'site' is equally good for hatching of eggs also.

Spiders play an important role in biological control of insect pests, but many insect pests like the red cotton bug *Dysdercus cingulatus*, which infest many cultivated and wild plants, take shelter in baya nests during winter. When winter passes, these insects come out from their 'hides', multiply and start a fresh attack on agricultural crops. Thus, abandoned nests of the baya are used by both useful and harmful arthropods.

I express my sincere thanks to Dr. B.K. Biswas, Zoological Survey of India, Calcutta, for identification of spiders, to Dr. Sushil Kumar, Entomologist, Forest Research Institute, Dehra Dun, for identification of the red cotton bug, and to Dr. Shiva Sharma, Dept. of Botany, University of Rajasthan, Jaipur, for guidance and encouragement.

August 10, 1989 SATISH KUMAR SHARMA

20. SOME FOOD PLANTS OF THE STAR TORTOISE *GEOCHELONE ELEGANS* AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

The star tortoise *Geochelone elegans* occurs in Point Calimere Wildlife Sanctuary, Tamil Nadu, and is commonly seen during monsoon in the open grazing lands. It is mostly crepuscular and omnivorous, but inclined to be vegetarian (THE BOOK OF INDIAN REPTILES, Daniel, J.C. 1983). During our field trips for the BNHS project at Point Calimere, whenever a star tortoise was encountered it was followed and a record of the plants eaten by the tortoise was maintained from 1987. Altogether seven food plants were identified and are listed in Table 1.

According to THE BOOK OF INDIAN REPTILES they feed on succulents such as *Cissus quadrangularis*, fallen fruits, grasses and similar vegetation. The food plants mentioned here give more precise data on the food plants of this tortoise.

TABLE 1
FOOD PLANTS OF STAR TORTOISE AT PT. CALIMERE

Species	Family	Part eaten
Alysicarpus monilifer	Papilionaceae	Leaves
Alysicarpus vaginalis	Papilionaceae	Leaves
Cyperus sp.	Cyperacea	Leaves
Dactyloctenium aegyptium	Gramineae	Leaves
Euphorbia hirta	Euphorbiaceae	Leaves
Ipomoea pescaprae	Convolvulaceae	Flowers
Pentatropis capensis	Asclepiadaceae	Leaves

S. ALAGAR RAJAN
November 26, 1990 P. BALASUBRAMANIAN

21. CANNIBALISM BY COMMON GARDEN LIZARD *CALOTES VERSICOLOR*

On 11 November 1990, at about 1100 hrs, I observed an adult common garden lizard *Calotes versicolor* on a thatched roof in the World Forestry Arboretum, Jaipur. The lizard was involved in a tussle with a subadult of its own species. Soon one more adult lizard appeared from nearby and tried to snatch the subadult from its competitor, but the first adult lizard immediately picked up the subadult in its mouth and rushed to a safer place, hardly five metres from the previous spot. It then started swallowing the unfortunate subadult head first, taking approximately eight minutes to complete the whole process of swallowing.

When it had completed swallowing, it was captured. It measured about 330 mm in length. The cannibalistic lizard was then imprisoned in a cage made of fine mesh to study its digestive capacity. Unfortunately on 14 November at about 0815 hrs it was freed by one of our labourers unknowingly. The empty case was scrutinised and three excreta pellets were found in it giving an indication of the slow digestion of the prey.

The food habits of the common garden lizard have been described in THE BOOK OF INDIAN REPTILES

(Daniel, J.C. 1983). It prefers insects but may occasionally take birds, nestlings, frogs and other small animals. Thus the preying on its own juveniles seems to be the first record.

January 7, 1991 SATISH KUMAR SHARMA

22. SOUTHERN GREEN CALOTES *CALOTES CALOTES* (LINN.) AT BANDIPUR

During our visit to the Bandipur Tiger Reserve (11°40′ to 11°55′ N, 76° 07′ to 76°52′ E) on 21 May 1988, we came across a southern green calotes *Calotes calotes* lying dead in the middle of Nilagiri road (about 3 km from the reception center) that passes through Bandipur and Mudumalai forests. The reptile, identified as per Smith (1935), had possibly been hit by a passing vehicle as its belly was ruptured and the entrails exposed, though most of its body was intact. On close examination, we counted seven whitish, oval-shaped, fully formed eggs within its belly.

Daniel (1983) considers the species to be chiefly arboreal, but this specimen with well formed eggs indicates that it may have been in search of an egg-laying site when it was killed, as the species is known to lay eggs in a hole in the ground (Daniel 1983).

The present sighting is the first record of the species in Bandipur and it has not been recorded during a previous survey there (Malhotra and Sahi 1982), although it is widely distributed in southern India. Though Murthy (1985) mentions that the species breeds in September, our observation of this female with fully formed eggs indicates that the species breeds in May also.

February 5, 1991 J.N. PRASAD
M.S. JAYANTH

REFERENCES

DANIEL, J.C. (1983): The Book of Indian Reptiles. Bombay Natural History Society. Bombay.

MALHOTRA, Y. R. & SAHI, D. (1982): Herpetofauna of Bandipur Tiger Reserve, Karnataka (India). *Tigerpaper IX(1)*: 17.

MURTHY, T.S.N. (1985): A Field guide to the Lizards of Western Ghats. Records of the Zoological Survey of India: miscellaneous publication No. 72. p. 51.

SMITH, M.A. (1935): The Fauna of British India: Reptilia and Amphibia. Vol. II. pp. 201-202.

23. BIFURCATED TAILED SKINK *LEIOLOPISMA HIMALAYANUM* (GUNTHER) FROM KINNAUR DISTRICT, HIMACHAL PRADESH

During the recent faunistic surveys of the high altitude areas of Kinnaur district in the Great Himalaya, a unique specimen of the skink *Leiolopisma himalayanum* with its tail bifurcated was collected from the bank of the river Vaspa in the Sangla valley. The bifurcation of the tail involves two-thirds of its length. Body length (snout to vent) was 65 mm. The other details are given below:

Material examined: 1 ex. Rakhcham, 16 km from Sangla, district Kinnaur, Himachal Pradesh, 4 Nov. 1988, M. Chandra (deposited in HAZFS, ZSI collection).

The literature indicates that herpetological fauna of Kinnaur district is yet to be studied (THE FAUNA OF BRITISH INDIA, Smith, M.A. 1935, THE BOOK OF INDIAN REPTILES, Daniel, J.C. 1983). It is worth recording that the population density of this species is very high in the Sangla valley as observed during two surveys in 1988. Further, the present record extends its range of distribution well north of Shimla hills.

March 28, 1991 R.N. MUKHERJEE
R. PALIWAL

24. BREEDING HABITS OF JOHN'S EARTH BOA *ERYX JOHNI*

Little is known about the breeding habits of John's earth boa *Eryx johni*, commonly known as the *andhadi chakalan* in Gujarat. Recently a pair of John's earth boa successfully bred in captivity. The gestation period was about 4 to 5 months. The female did not consume any food during the last three months of this period. She gave birth to 14 young ones ovo-viviparously in July, which is double the number of offspring as mentioned in THE BOOK OF INDIAN REPTILES (Daniel, J.C. 1983). The young ones were 28 cm long with girth of 5 cm. They were totally different from the adult in their coloration, being light pink in colour with brown blotches on the back.

January 28, 1991 ASIF R. KHAN

25. UNUSUAL PATTERN AND VARIATIONS IN SCALES OF THE COBRA *NAJA NAJA* (LINN.)

(*With a text-figure*)

Variations in the number of labial, ocular, temporal, ventral and caudal scales in many species of snakes have been reported by various authors (Khan 1985, Mathew 1983). Recently I studied and identified a young cobra from the collections of St. Edmund's college, Shillong, as *Naja naja* (Linnaeus) (variety *kaouthia*). This specimen has an unusual scale pattern on the head: a single pair of scales in place of the paired prefrontals and internasals as illustrated in Fig. 1.

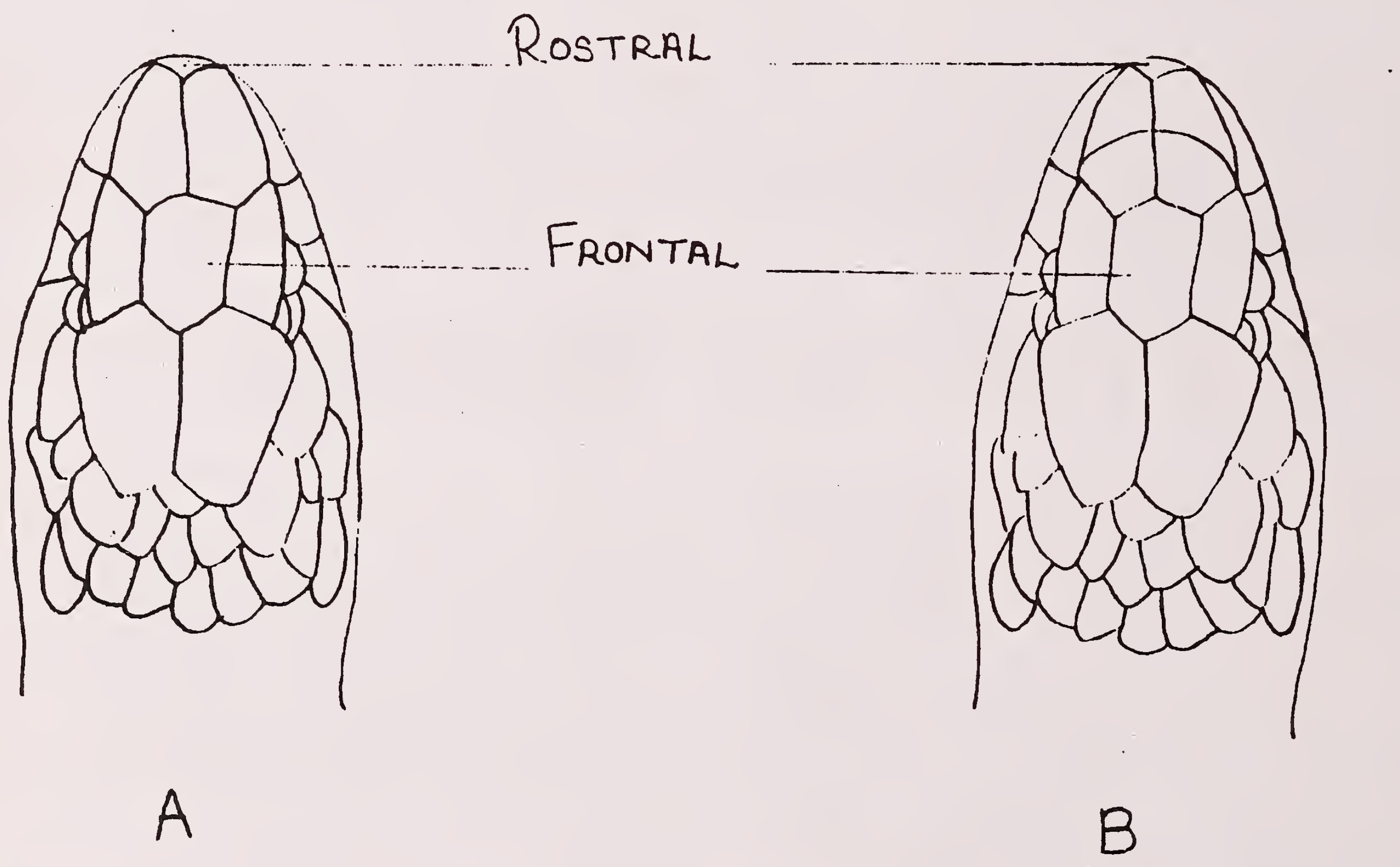


Fig. 1. Diagrammatic representation of the cobra head. A. Unusual scale pattern, B. Usual pattern.

Other variations observed are 21 scales in the anterior portion of the body as against the 25-31 recorded by Smith (1943); anterior two caudals single as against the usually all-paired caudal; and five supralabials with the second and third touching the eye as against the seven supralabials with the third and fourth touching the eye as recorded by Smith.

March 9, 1991 R. MATHEW

REFERENCES

KHAN, M.S. (1985): An interesting collection of Amphibians and Reptiles from Cholistan desert, Punjab, Pakistan. *J. Bombay nat. Hist. Soc. 82:* 144-148.

MATHEW, R. (1983): On a collection of snakes from North-East India (Reptilia: Serpentes). *Rec. zool. Surv. India 80:* 449-458.

SMITH, M.A. (1943): Fauna of British India, Ceylon and Burma, including the whole of the Indochinese subregion. Reptilia and Amphibia, III Serpentes. London.

26. RECORD OF *COLISA LABIOSA* (DAY) (PISCES: BELONTIDAE) FROM INDIA

During the course of a survey of the fish fauna of Assam in 1990-91, three specimens of a belontid fish *Colisa labiosa* (Day) were collected from a beel near Jorhat, Assam (94° 10′ E, 26° 44′ N). *C. labiosa* is a Burmese form, found in the Irrawady at Rangoon and as high as Mandalay (THE FISHES OF INDIA, Day, F.1878; THE FRESHWATER FISHES OF INDIA, Jayaram, K.C. 1981; Bhattacharyya, pers. comm. 1991. Perusal of literature revealed that *C. labiosa* has not so far been recorded from India. The fish was identified with the following diagnostic characters.

D.XV-XVI, 10-12; P.10; V.1; A.XVII, 16-17; C.15

Head length 4.20-4.25 and body depth 2.60-3.40 in total length (84-102 mm). Eye diameter 3.43-3.50 and interorbital distance 2.18-2.21 in head length. Lips very thick and covered with papillae as in *Labeo*. Maxilla reaches to below the anterior nostril. Soft portions of dorsal and anal fins elongated and caudal wedge-shaped. Eight to ten obliquely vertical bluish bars are present on the sides. A light yellowish red band from the eye across the lower jaw behind the lip. Outer edge of anal is yellowish red.

The number of spines and rays in both the dorsal and anal fins of the present specimens was not identical with those recorded by Day (1878). The possibility of such variations in *Colisa* has already been indicated (Day 1878).

C. labiosa is allied to the north Indian species *C. fasciata,* but differs in its thick papillated lips, wedge-shaped caudal fin and the number of bands on the sides. The specimens are preserved in the laboratory of Fisheries Research Unit, Assam Agricultural University, Jorhat.

We thank Dr. (Miss) N. Sen, ZSI, Shillong for confirming the identification and Dr. S.K. Bhattacharyya, ZSI, Calcutta, for helpful comments.

A.K. BHAGOWATI
May 21, 1991 B.K. BISWAS

27. HOST ASSOCIATION AND UNDESCRIBED ALATE VIVIPAROUS FEMALE OF *MATSUMURAJA CAPITOPHOROIDES* HILLE RIS LAMBERS (HOMOPTERA: APHIDIDAE)

(With five text-figures)

The genus *Matsumuraja* Schumacher has 15 species distributed in China, Formosa, India, Japan and Pakistan. Most of the species infest *Rubus* spp. (except *M. urtica* Ghosh *et al.* and *M. intermedia* Saha *et al.* which are known from plants of the family Urticaceae). Only *M. rubifoliae* Takahashi is known from two hosts, and alternates between *Clethra barbinervis* (primary host) and *Rubus* spp. (secondary host). Sexual morphs of only *M. rubifoliae* are known. This shows that most of the species under this genus are autoecious and anholocyclic.

In India, 5 species under this genus are known. *M. capitophoroides,* originally described from Pakistan, has been reported subsequently from northwestern, western and north-eastern Himalaya (Chakrabarti and Raychaudhuri 1975, Chowdhuri *et al.* 1969, Ghosh *et al.* 1971 and Raychaudhuri 1980). Hille Ris Lambers (1966) while describing this species, stated that the species does not show any host alternation. Chowdhuri *et al.* (1969) reported this species both from *Rubus macilentus* and an

unidentified graminaceous plant. The sample from Gramineae was collected in the month of September. Recently, we also observed a few colonies of this species infesting *Poa annua* during post monsoon period and these colonies persisted there till the winter and then migrated elsewhere. This shows that *M. capitophoroides* Hille Ris Lambers is a host-alternating species and alternates between plants of Rubiaceae, Rosaceae and Gramineae.

So far this species was known by only apterous viviparous females on *Rubus* spp. The hitherto unknown alate viviparous females and apterous viviparous females collected on *Poa annua* are described here. Besides, some additional characters of apterous viviparous female on primary host are also given.

Apterous viviparous female (on grass): Body elongated, 1.54-1.80 mm long and 75-85 mm wide. Head with moderately developed lateral frontal tubercles, dorsum with 8 hairs on developed socket, longest hair on vertex 47-49 μm long and 1.90-2.33 times the basal diameter of antennal segment III. Processus terminalis 2.58-2.84 times the base of the segment and 1.23-1.37 times the segment III; antennal process on segment I 0.35 mm long, 3.1-3.4 times its basal width and 3.36-4.22 times the basal diameter of antennal segment III. Abdominal dorsum with thick and blunt hairs located on elevated cone; each tergite with 6 hairs; longest hair on anterior tergite 47-50 μm long and 2.0-2.20 times the basal diameter of antennal segment III, longest spinal hair on 7th and 8th tergites 79-94 and 58-79 μm long and 3.09-4.0 and 2.50-2.90 times the basal diameter of antennal segment III respectively. Siphunculi 0.23-0.25 times the body and 3.1-3.9 times the cauda. Otherwise as in apterous viviparous females on *Rubus* spp. and on *Rosa* spp.

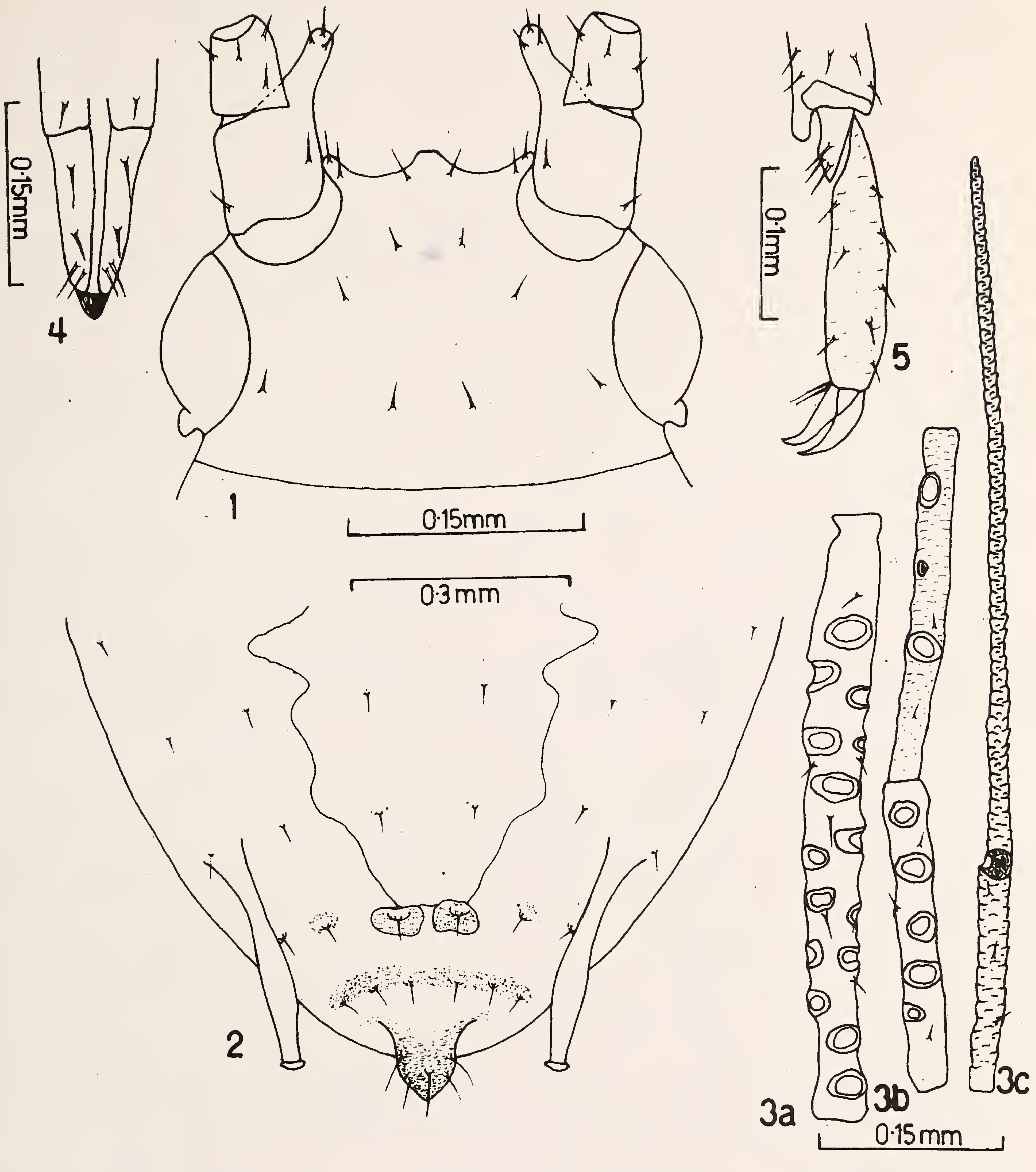
Measurements of one specimen (in mm): Body length 1.64, width 0.84; antennal length 1.08, antennal segments III:IV:V:VI 0.28: 0.17: 0.20: (0.12+0.35); ultimate rostral segment 0.10; second joint of hind tarsus 0.10; siphunculus 0.44; cauda 0.11.

Alate viviparous female (on grass) (Figs. 1-5): Body 1.76-2.0 mm long and 0.80-0.89 mm as maximum width. Head dark brown, smooth, with moderately developed lateral frontal tubercles and median prominence; dorsum with 8 small, stout and pointed hairs, except on lateral frontal tubercles and median prominence, each of which with a pair of hairs, longest one on head 188-235 μm long and 0.72-0.83 times the basal diameter of antennal segment III.

Antennae 6 segmented, 0.69-0.74 times the body, concolorous with head, smooth except segment IV which is imbricated apical; processus terminalis 2.53-3.0 times the base of the segment and 1.05-1.11 times the segment III; segment I with a strongly developed antennal process which is 0.037-0.039 mm long, 2.28-2.42 times its basal width and 1.41-1.45 times the basal diameter of antennal segment III, with 3 hairs; segments I, II and III with 2, 4 and 5-6 hairs respectively, flagellar hairs small and pointed, longest one on segment III 117 μm long and 0.45 times the basal diameter of antennal segment III; segments III, IV and V with 15-18, 5-7 and 2-3 oval to rounded secondary rhinaria respectively; primary rhinaria non-ciliated.

Rostrum reaches nearer to mid-coxae, ultimate rostral segment 0.093 mm long and as long as second joint of hind tarsus and with a pair of accessory hairs. Thorax dark brown, strongly sclerotised, mesothoracic lobe with a broad base; wing veins normal, pale brown in colour, pterostigma long, pointed and scaly. Legs concolorous with head, smooth except spinulated coxae and faintly imbricated second tarsal segments; first tarsal segments with 3 hairs. Abdominal dorsum membranous, smooth except marginal spinules; abdominal segments 1, 2, and 8 with separate small spinal patches, marginal patches on anterior tergites not discernible but present on tergites 6-8, tergites 3-7 with a large brown spinopleural patch; dorsal hair small, acute to acuminate, each tergite with 6 hairs, on anterior tergites 4-8 on small elevated cones, those on 7th tergite large; longest hair on anterior tergite 164-188 μm long and 0.63-0.66 times the basal diameter of antennal segment III, those on 7th and 8th tergites 352 μm long, and 1.16-1.36 times the basal diameter of antennal segment III respectively.

Siphunculi elongated, brown in colour, smooth except basal cylindrical imbricated part, apical part elevated; 0.17-0.19 times the body and 3.60-4.22 times the cauda. Cauda pentagonal with 5 hairs. Venter spinulose, ventral hairs numerous, larger and thinner than dorsal hairs; genital plate with 6 hairs on anterior margin in 2 groups each with 3 hairs, and 12



Figs. 1-5. *Matsumuraja capitophoroides* Hille Ris Lambers. Alate viviparous female.
1. Head, dorsal view. 2. Abdomen, posterior part. 3a. Antennal segment III. 3b. Antennal segments IV and V. 3c. Antennal segment VI. 4. Ultimate rostral segment. 5. Hind tarsal segments.

hairs on posterior margin in a half round row. Other characters as in apterous viviparous females on *Rubus* spp. and *Rosa* spp.

Measurements of one specimen (in mm): Body length 2.0, width 0.80, antennal length 1.38, antennal segments III:IV:V:VI 0.34:0.17:0.20: (0.14 + 0.36); ultimate rostral segment 0.09; second joint of hind tarsus 0.09; siphunculus 0.36; cauda 0.08.

Apterous viviparous female (on *Rosa*): Re-examination of additional materials collected from *Rosa* sp. reveals that the description of this species should be modified as follows:

Body 1.84-2.17 mm long and 0.75-0.106 mm wide; processus terminalis 1-1.23 times the length of the antennal segment III; longest hair on antennal segment III 0.29-0.46 times the basal diameter of the segment; ultimate rostral segment 0.93-0.96 times the second joint of hind tarsus; siphunculi 0.20-0.23 times the body and 2.75-3.46 times the cauda.

Material examined: 4 apterae, *ex Rosa* sp., Bhowali (*c.* 1770 m), 24 May 1969, coll. S. Chakrabarti; 10 apterae, 2 alatae and 12 nymphs, ex *Poa annua,* Joshimath (*c.* 1845 m), 5 Sep. 1988, coll. S. Chakrabarti (Coll. No. 6389).

ACKNOWLEDGEMENTS

We thank the Head, Department of Zoology, for laboratory facilities. The financial assistance received from the Council of Scientific and Industrial Research and University Grants Commission for the work is also acknowledged.

PRADIP KUMAR BANERJEE
SUMIT CHAKRABARTI
SAMIRAN CHAKRABARATI

May 12, 1990.

REFERENCES

Chakrabarti, S. & Raychaudhuri, D.N. (1975): Aphids (Homoptera: Aphididae) from Sundardhunga valley, Kumaon Himalayas, India. *Oriental Insects 9(2):* 195-211.

Chowdhuri, A.N., Basu, R.C., Chakrabarti, S. & Raychaudhuri, D.N. (1969): Aphids (Homoptera) of Simla (Himachal Pradesh), India. *Oriental Insects 3(1):* 83-92.

Ghosh, A.K., Ghosh, M.R. & Raychaudhuri, D.N. (1971): Studies on the aphids (Homoptera: Aphididae) from Eastern India. *Oriental Insects 5(2):* 209-222.

Hille Ris Lambers, D. (1966): New and little known aphids from Pakistan (Homoptera: Aphididae). *Tijdschr. voor Ent. 109(8):* 193-221.

Raychaudhuri, D.N. (Ed.) (1980): Aphids of north-east India and Bhutan. The Zoological Society, Calcutta.

28. TAXONOMY OF SOME INDIAN *TENTHREDO* LINN. (HYMENOPTERA: TENTHREDINIDAE)

Singh and Saini (1988) described some new species of *Tenthredo,* including *T. malaisei* and *T. petiolata*. Dr. A. Taeger of Eberswalde has pointed out that *T. malaisei* Singh and Saini, 1988 is a junior secondary homonym of *Tenthredo bipunctula malaisei* Takeuchi, 1933. Therefore a new name *Tenthredo pseudoappendicella* n. nov. is proposed here to replace the junior homonym.

Similarly *T. petiolata* Singh and Saini, 1988 turns out to be a junior synonym of *T. aeruginea* Enslin, 1912. Though we could not trace the holotype of *T. aeruginea,* the holotype of *Allantus brunnea* Cameron, 1899, established as its synonym by Malaise, 1945, was made available to us for comparative studies through the kind courtesy of Dr. N.D. Springate of BMNH, London. This holotype (with labels- "*Allantus brunneus* Cam. Type, Khasia", "BMNH", "956") resembles completely the holotype of *T. petiolata* (with labels *Tenthredo petiolata* Singh & Saini, "Uttar Pradesh, Mandal, 2300 m, 13.6. 1983", Holotype). Though there are some colour differences, these can easily be considered as population variation. Hence *T. petiolata* Singh and Saini should be taken as a junior synonym of *T. aeruginea* Enslin.

DEVINDER SINGH
M.S. SAINI

April 10, 1990.

REFERENCES

Cameron P. (1899): Hymenoptera Orientalia, or a knowledge of the hymenoptera of the Oriental

Zoological Region. Part VIII. The Hymenoptera of Khasia Hills, First paper. *Mem. Proc. Manch. Lit. Phil. Soc. 43(3):* 220.
ENSLIN, E. (1912): Ueber *Tenthredo (Allantus) albiventris* Mocs. and *trivittata* Ed. Andre sowie ueber einige Namensanderungen bei *Tenthredo* und *Tenthredella*. *Arch. Nat. Berlin 78:* 101–106.
MALAISE, R. (1945): Tenthredinoidea of south-east Asia with a general zoogeographical review. *Opus. Ent.,* suppl. *4:* 288.
SINGH, D. & SAINI, M. S. (1988): Six new species of *Tenthredo* Linn. from the Western Himalayas (Insecta: Hymenoptera: Symphyta: Tenthredinidae). *Reichenbachia Stat. Mus. Tier. Dresden 28:* 137-147.
TAKEUCHI, K. (1933): Undescribed sawflies from Japan. *Trans. Kansai ent. Soc. Okasa 4:* 17-34.

29. SWARMING OF BUTTERFLIES

On 7 May, 1989 at about 0600 hrs, near Haflong in Assam, the day was as exceptionally fine and sunny. I noticed a large number of butterflies flying around. I did not pay much attention then, assuming that this was due to the fine weather. By 0830 hrs, the butterflies were flying in groups of fifties or more. Within an hour, they were flying in hundreds, purposefully from north to south, hardly 2-3 m above ground level but sometimes overflying trees 10 to 15 m high.

There were mixed swarms of different species of which I could identify only the large cabbage white *Pieris brassicae* and the white orangetip *Ixias marianne*. By 1230 hrs, the main swarm had flown past, though stragglers kept flying southwards till late evening.

On the same day, I saw a swarm at Jatinga, about 8 km south of Haflong. During the same week, one of my colleagues saw a large number of butterflies while driving from Lumding to Diphu Road about 100 km north of Haflong. I had never seen such swarming of butterflies and was not aware of such swarming in India.

March 3, 1990 K.K. GUPTA

30. ON THE MIGRATION OF THE LARGE CABBAGE WHITE BUTTERFLY *PIERIS BRASSICAE* IN KASHMIR[1]

(With a text-figure)

The large cabbage white *Pieris brassicae* is common in the western Himalayas. It is an altitudinal migrant, descending to plains and lower hills in winter and migrating back in summer (Wynter-Blyth 1957). The mass movements of this species are conspicuous and well documented in Europe (Williams 1930), but the published data from India is fragmentary. The following is one such instance of migration of this species.

The location was the western ridge of the Overa Wildlife Sanctuary, Kashmir, the altitude being 3800 m. On one side the ridge falls sharply towards Liddar valley and on the other side the slope is gradual towards the Jhelum valley. The top of the ridge is narrow at some places, broadening to grassy meadows strewn with alpine flowers. The ridge is flanked by stands of silver birch (*Betula* sp.), sparser near the top.

The mass movement of butterflies was first noted on the morning of 28 May 1988. The weather was calm, clear and sunny, and remained thus throughout. It continued till afternoon of the next day. Thereafter it became cloudy, overcast with a hint of rain. As we became aware of the sudden influx of butterflies it became apparent that a migration was in progress. The butterflies were coming up the ridge in an incessant stream. The flight was rapid in one direction and the butterflies were flying on, hardly resting. They kept mostly to the crest of the ridge, and at the centre the air appeared to be thick with butterflies, flying from ground level almost till the eye could reach. So striking and conspicuous was this movement that it was impossible not to notice it. The direction of the flight was from south to north (Fig. 1).

The flight of the butterflies was followed uptil a point where the ridge rises sharply to about 4000 m.

[1] This note was earlier published in Vol. 88 No. 1. Due to a production error, part of the text was omitted. The entire note is therefore being reproduced here.

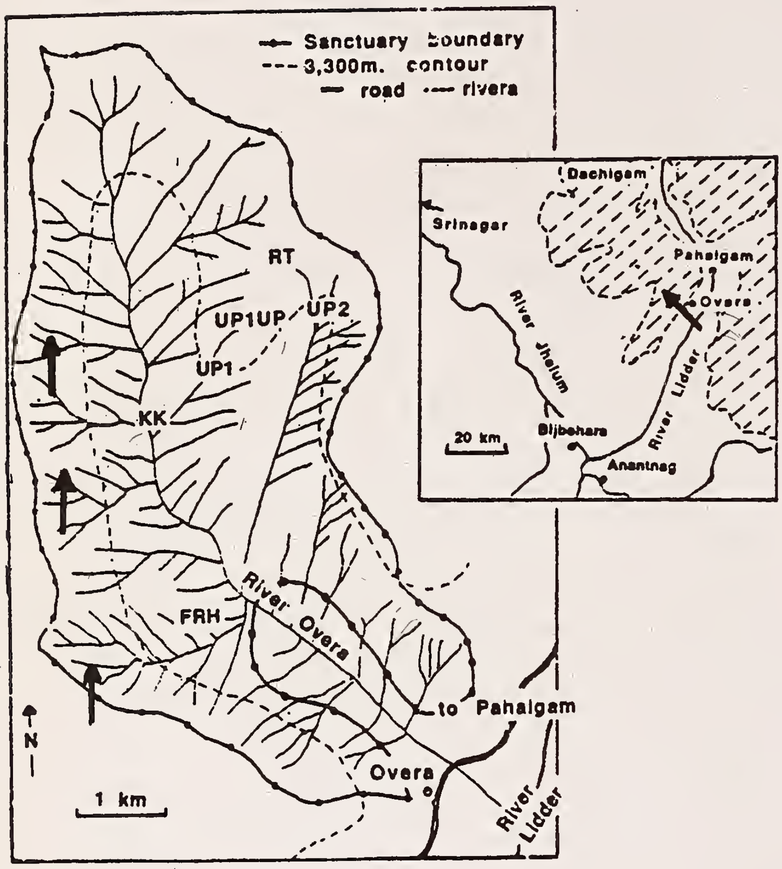


Fig. 1. Overa Wildlife Sanctuary. Dotted line is the approximate 3300 m contour. Arrow shows direction of butterfly migration.

Here the butterflies were fluttering up close to the cliff face in a scrambling flight and disappearing over the top. The flow continued in profusion till afternoon of the next day, then became sparse and irregular. To estimate the total number of butterflies, the number passing through an area 30 m high and 30 m in width were counted at 1140 hrs on 28 May, by using a chronometer. In two minutes, 102 butterflies passed through the segment. The butterflies passing outside this segment were not counted. By a crude estimate, considering that a very negligible portion was flying through the segment, at least 75,000 to 80,000 butterflies passed the camp site in the day and a half. Despite such abundance of cabbage white butterflies and presence of black swift *Apus apus*, hobby *Falco subbuteo*, kestrel *Falco tinnunculus*, predation was not noticed. This butterfly is considered as distasteful.

There are a few reports on migration of *Pieris brassicae*. Hingston (vide Williams 1930) has described the phenomenon at Dharamshala, stating, "Great flight for two months along with *Colias fieldi*, a few *D. chrysippus*, *V. cashmirensis* and *P. boeticus*, going up the hill at 1800 m. Many right up to the snowline at 2800 m. Here flying more to the north. In mid-April, hillside white with fluttering wings. Independent of climatic change except greatest when sun shines." This butterfly is noted as migrant by Wynter-Blyth (1957), Maxwell-Lefroy (1909) and Fletcher (1914). All the authors make generalised remarks without stating specific records. Maxwell-Lefroy (1909) states that this butterfly migrates to sub-mountain Himalayas and breeds on the cultivated crucific and returns to the hills in summer. In view of the paucity of records as stated above, this observation is worth placing on record.

Another summer season (May-June 1989) was spent in the same area, but the migration was not noticed. Specimens of *P. brassicae* were collected and added to the BNHS collection. The identification was confirmed by Mr. Naresh Chaturvedi. Thanks are also due to him for help with references.

Similar other records of migration of this species will be worth placing on record so as to eventually plot a definite route/pattern of migration.

October 12, 1989 NITIN JAMDAR

References

MAXWELL-LEFROY, H. (1909): Indian insect life. Reprinted by Today and Tommorrow's Publishers. New Delhi.

WILLIAMS, C.B. (1930): The migration of butterflies. Oliver and Boyd, Edinburgh.

FLETCHER, T.B. (1914): Some south Indian insects. Govt. Press, Madras.

WYNTER-BLYTH, M.A. (1957): Butterflies of the Indian region. Bombay Natural History Society, Bombay.

31. RECORD OF *CITRIPESTIS EUTRAPHERA* (MEYRICK) (PYRALIDAE: LEPIDOPTERA) ON *MANGIFERA ANDAMANICA* IN INDIA

(With a text-figure)

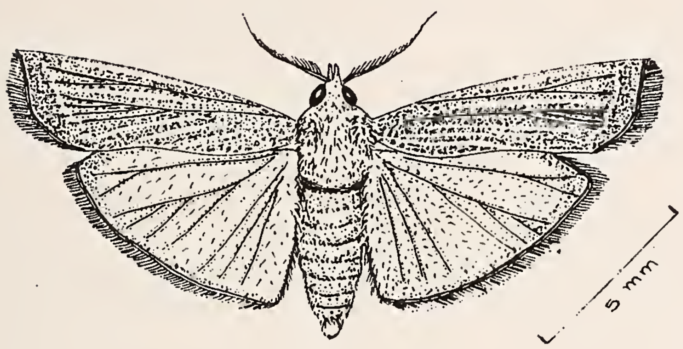


Fig. 1. *Citripestis eutraphera* (Meyrick)

Mango is cultivated in 103 ha. area in Andaman and Nicobar islands (Agricultural Census Report 1980-81, State Statistical Bureau for A & N Islands). During a survey the fruits of *Mangifera andamanica* were found infested by the larvae of *Citripestis eutraphera* (Meyrick).

M. andamanica produces fruits in bunches. Fruits of 4-5 cm diameter were preferred for oviposition. Brownish larva entered the fruit at the sinus region and fed on the pulp and contents of nut. The infested fruits dropped prematurely. The caterpillar, once fully grown, measured 20 mm in length. It pupated in loosely woven silken cocoon in the soil adjacent to the fallen fruit. On an average 27% of fruits were infested by this insect.

The adult is a medium sized moth with a wing span of 17 mm. Forewings are grey without any specific markings, whereas hind wings are transparent (Fig. 1).

The insect fauna of Andamans has more in common with that of Malaysia and Indonesia than that of India, though there is much influence from mainland Asia via Burma and Thailand (M. Shaffer, pers. comm. 1989). Hussein and Rahman have reported that *C. sagittiferella* bores lemon fruits in Malaysia (*Malaysian Agri. Jour. 53(1):* 45-51). *C. eutraphera* was earlier described from Java and has been recorded from Sumatra (M. Shaffer, pers. comm. 1989). This is the first record of *C. eutraphera* on *Mangifera andamanica* from South Andaman in India.

I am grateful to the Director, Central Agricultural Research Institute, Port Blair, for providing facilities and to Dr. M. Shaffer, Commonwealth Institute of Entomology, British Museum (Natural History), London, for identifying the insect.

March 6, 1990

B.S. BHUMANNAVAR

32. *EXCOECARIA AGALLOCHA* L.— AN ADDITIONAL HOST TO THE LONG-HORNED BEETLE *STHENIAS GRISATOR* FB. (CERAMBICIDAE: COLEOPTERA) FROM POINT CALIMERE SANCTUARY, TAMIL NADU

The long-horned beetle, generally called the grape vine stem girdler, is reported to girdle the base of the stem of the host plant with its powerful mandibles, arresting the supply of sap and thus killing the particular branch. The beetle lays its eggs in a hole in the dried up branch, and the larvae tunnel into the hole and feed on the dead wood (Fletcher 1914). The beetle is nocturnal, cryptically coloured and hides under the forks of the branches during the day. In addition to grape plant it has been reported to attack plants such as bougainvillea, cacao, casuarina, erythrina, jack, mango, rose, *Morus indica* and *Tabernoemontana alba* (Maxwell-Lefroy 1909, Fletcher 1914, Nayar *et al.* 1981). Balasubramanian (1990) reported this beetle attacking *Jatropha gossypifolia* and *J. curcas* (Euphorbiaceae) at Point Calimere Sanctuary, Tamil Nadu.

Excoecaria agallocha L. (Euphorbiaceae) is a small evergreen tree species with poisonous milky sap, commonly noticed in the swampy areas at Point Calimere. During February 1990, large scale dying of *Excoecaria agallocha* branches was noticed at two sites, Muniappan lake and Light House swamp.

200 individuals of this tree species, 100 from

each of the study sites, were checked for the infestation. A total of 43 individuals in the Muniappan lake and 58 individuals in the Light House swamp were found infested. In most cases the branches had been girdled. One to five stems in a plant had been attacked. Stems ranging in diameter from 4 to 11 cm were girdled. In all the individuals, the portion of the branch above the girdled area was found totally dried up.

It is of interest to note that all the three plant species attacked by this beetle in Point Calimere Sanctuary belong to the family Euphorbiaceae. All three species have very soft wood (Gamble 1986), making it convenient for the beetle to girdle the stem.

May 12, 1990 P. BALASUBRAMANIAN

REFERENCES

BALASUBRAMANIAN, P. (1990): *Jatropha gossypifolia* L. and *Jatropha curcas* L.–New host plants for the long-horned beetle *Sthenias grisator* Fb. (Cerambicidae: Coleoptera). *J. Bombay nat. Hist. Soc. 87(1)*: 165-166.

FLETCHER, T.B. (1914): Some South Indian insects and other animals of importance. Reprinted by M/s Bishen Singh Mahendra Pal Singh, Dehra Dun. pp. 149-159.

GAMBLE, J.S. (1986): Flora of the Presidency of Madras. Reprinted by M/s Bishen Singh Mahendra Pal Singh, Dehra Dun. pp. 1339-1345.

MAXWELL-LEFROY, W. (1909): Indian Insect Life: A manual of the insects of the plains. Govt. of India, Pusa. pp. 368-379.

NAYAR, K.K., ANANTHAKRISHNAN, T.N. & DAVID, B.V. (1981): General and Applied Entomology. Tata McGraw Hill Publishing Co. Ltd., New Delhi. pp. 328-362.

33. OCCURRENCE OF *COPIDOGNATHUS HARTWIGI* BARTSCH (HALACARIDAE: ACARI) FROM THE INDIAN OCEAN

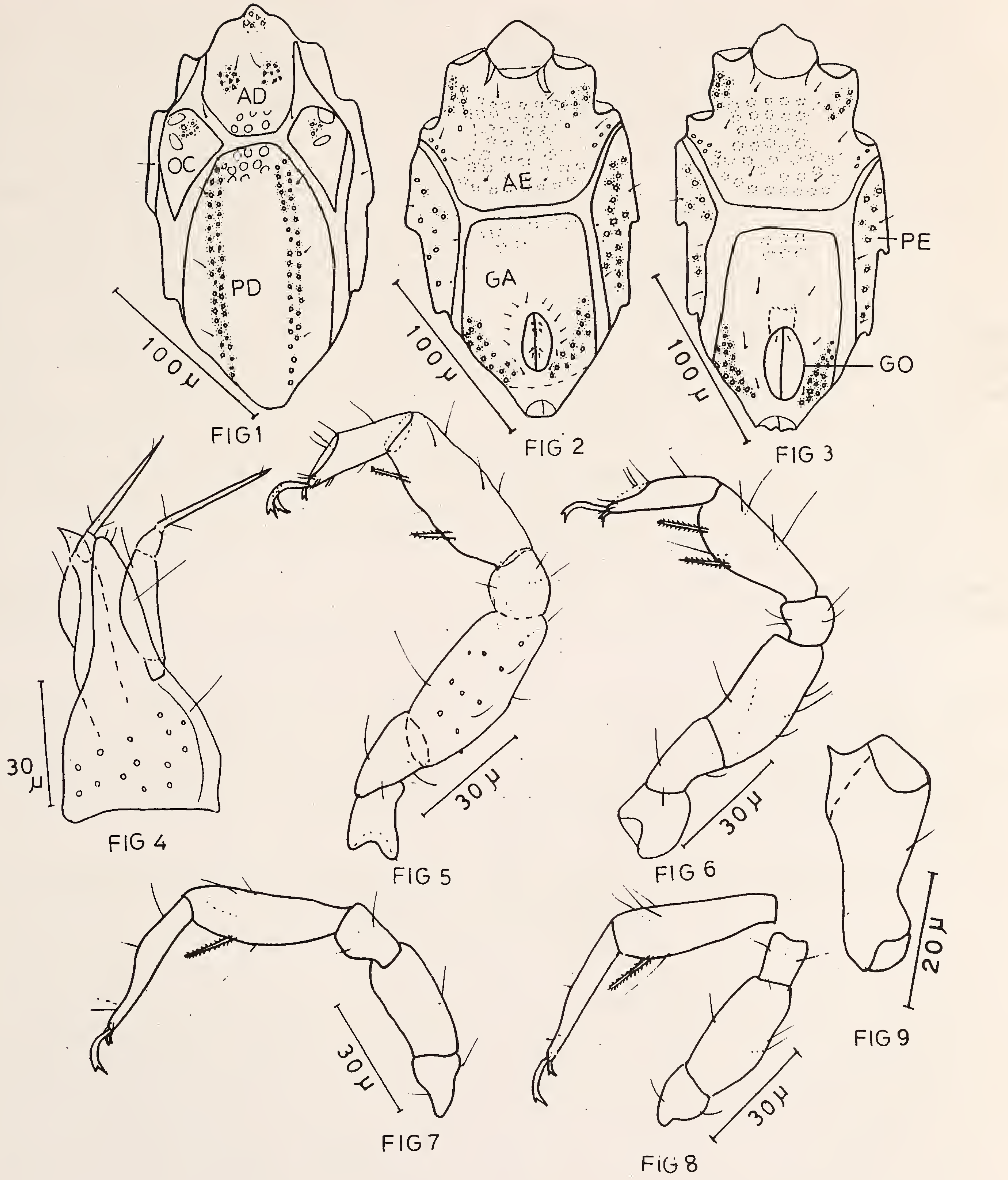
(With a text-figure)

During studies on the biosystematics of Halacaridae of the Indian coast, a large number of halacarids, many of which either are new to science or new to the Indian ocean region or only infrequently recorded, were collected. A comprehensive report of the investigation will be published elsewhere. Presently, the occurrence of *Copidognathus hartwigi* Bartsch 1978 is reported here for the first time, not only from the Indian coast but also from the Indian ocean. The description of males is also provided here since the males have not so far been described.

C. hartwigi has been reported so far from the upper littoral zone of Bermuda among algae (Bartsch 1978) and from the Irish sea near Strangford Narrows among the sublittoral sediments at 30-42 m depth (Bartsch 1985, Green and Macquitty 1987). In the present survey, five specimens (3 males and 2 females) of *C. hartwigi* Bartsch 1978 were obtained from the littoral algal tufts of *Halimeda opuntia* collected from Mus Island (Nicobar islands, Bay of Bengal). A brief description of the male and female of the species is given.

Male: The length of idiosoma of the males ranged from 216 to 227 μ. All dorsal plates are separate (Fig. 1), sculptured with rosette pores and panelled. Antero-dorsal plate (AD) with one anterior and two circular posterior areolae. Dorsal seta 2 (ds_2) lies in the membranous area between AD and ocular plate (OC).

The length of postero-dorsal plate (PD) is twice that of its width. Two parallel costae are present on PD. Costae are two pores wide. The dorsal setae 3-5 (ds_3, ds_4, ds_5) are located between costae and the lateral margin of PD. Ventral plates are separate (Fig. 2). Epimeral process 1 (Ep1) is coxal in origin. Genito-anal plate (GA) bears paragenital areolae and porose panels. Seven perigenital setae (PGS) on either side of the genital opening (GO) and four pairs of subgenital setae (two located anteriorly and two posteriorly on the GO) are present. Gnathosoma is slender. Rostrum is long and extends up to the base of palpal tibiotarsus (Fig. 4). Gnathosoma is sculptured dorsally with foveae and ventro-laterally with porose panels. Palp 4-segmented. Palpal trochanter and patella are without any setae. Palpal femur with one dorsal seta, palpal tibiotarsus with 3 basal setae,



Figs. 1-9. *Copidognathus hartwigi*

1. Idiosoma dorsal, male, 2. Idiosoma ventral, male, 3. Idiosoma ventral, female, 4. Gnathosoma, 5. Leg I, 6. Leg II, 7. Leg III, 8. Leg IV, 9. Trochanter

besides one minute distal eupathidia.

Chaetotaxy of legs is as shown in Figs. 5-8. Trochanter I bears a postero-dorsal spine (Fig 9). Telofemorae III and IV with 0:1 ventral setae, tibiae III and IV each with two ventral setae (one pectinate and one slender). Tarsi III and IV with 4 and 3 dorsal setae respectively.

Female: The idiosomal length of female ranged between 212 and 237 μ. The female resembles the males in almost all respects except the GA and in having relatively wider membranous zones between the body plates of dorsum and venter. GA bears paragenital areolae and three pairs of perigenital setae around GO. One pair of Subgenital Setae are present on the GO (Fig. 3). Ovipositor is small.

The costae are two pores wide in the present Indian Ocean specimens, while in the Bermudan specimens the costae are only one pore wide (Bartsch 1978). Green and Macquitty (1987) figured costae two pores wide for their British coast specimens but made no mention of it in the text. Considering the available descriptions from Bermuda and British coasts and the present one it appears that the width of the costae is variable.

C. hartwigi was collected among the thalli of upper littoral algae in both the Bermudan and Indian coasts. But in the British coast, the species was found in sublittoral sediments. When the variations in the width of the costae are viewed against the diversity of the habitats of *C. hartwigi* in different geographic regions, it becomes apparent that the intraspecific morphological diversity reflects not only the impact of latitudinal variations, huge intervening water masses and land barriers but also the influence of local and regional habitat fragmentation, niche formation and segregation. Studies should be made to elucidate the morphological variants occurring within the same or different biogeographical realms.

Thanks are due to Dr. Ilse Bartsch, Biologische Anstalt Helgoland, Hamburg (FRG) for her ready help in providing literature, and to the authorities of Regional College of Education, Bhubaneswar, for extending laboratory facilities.

A.L.N. SARMA
May 31, 1990 TAPAS CHATTERJEE

REFERENCES

BARTSCH, I. (1978): *Copidognathus hartwigi* n. sp. (Halacaridae, Acari) Eine Meeresmilbe Neu Fur Die Fauna Der Bermudas. *Acarologia 20:* 93:96.

BARTSCH, I. (1985): Halacaridae (Acari) from the Strangford Narrows and the Irish sea. *Proc. R. Jr. Acad. 85(2):* 21-35.

GREEN, J. & MACQUITTY, M. (1987): Halacarid Mites. Synopsis of the British Fauna (new series) No. 36. Eds. Dorls M. Kermack & R.S.K. Barnes – The Linnean Soc. of London & The Estuarine and Brackish-water Sciences Association.

34. TERATOLOGICAL NOTES ON THE FRUIT OF *CHIONANTHUS RAMIFLORUS* ROXB.

(With a text-figure)

While scrutinising the herbarium specimens of the family Oleaceae from the Andaman and Nicobar islands at Botanical Survey of India, Port Blair herbarium (PBL), I came across an interesting specimen of *Chionanthus* L. collected by N.G. Nair *3534* from Car Nicobar island.

The specimen does not match with any Indian species of the genus from the peculiar size and texture of the fruit. The fruit was 3.5-5.5 cm long with 8 ridges. The specimen matches with *Linociera beccariana* Stapf, known from Sumatra, in having similar leaf shape, size, texture, size of the petiole and eight ridges on fruit, but differs in not having flattened internodes, short and thin petioles, less thickened peduncles and pedicels.

Later the specimen was sent to Dr. Ruth Kiew for confirmation of its identity. Kiew in her reply stated that "...the fruits on your specimen are exceptionally large (the largest I had previously seen on other specimens was 2 cm long). It belongs to *Chionanthus ramiflorus* Roxb.... the fruit is also typical in having a thin, brittle pericarp and in the seeds being exalbuminous. Its ridges are the result of superficial vascular bundles (in *L. beccariana* the pericarp is thick and even the inner surface shows the ridges.)..."

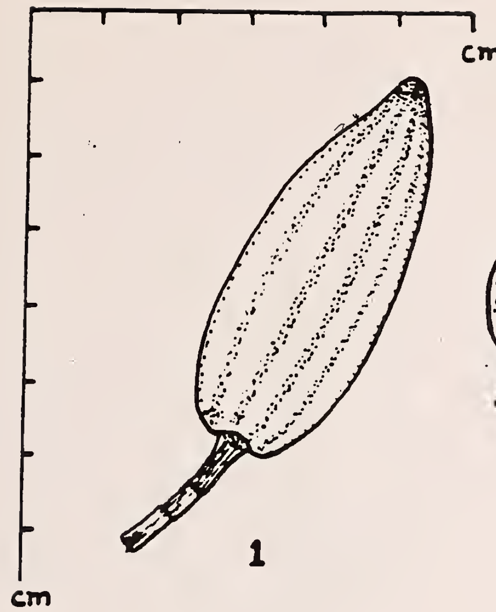


Fig. 1. Fruit of *Chionanthus ramiflorus*. 1. Fruit (Nair 3534 PBL) of peculiar size, 2. Fruit (Chakraborty 3801 PBL) of

I have also not come across such peculiarity in the fruits of *C. ramiflorus* Roxb. during the course of my revisionary study of Indian Oleaceae.

However, the comparison of the total characters of *C. ramiflorus* shows that our specimen is otherwise normal except in drupe size and texture. It is noticed that usually teratological forms develop due to fungus or insect attacks. Teratology plays an important role in the phylogenetic interpretations as stated in PRINCIPLES OF PLANT TERATOLOGY (Worsdell, W.C. 1915). *C. ramiflorus* with such large fruit and prominent ridges could easily misguide the explorer. To facilitate easy identification of the species in the field, fruits have been illustrated in Fig.1.

Hence, it is clear that this gigantism in fruits of *C. ramiflorus* is not hereditarily fixed, but further observation of this type of gigantism in plant parts may give clues to their phylogeny.

I am grateful to Dr. Ruth Kiew, Department of Biology, Agriculture University, Malaysia, for confirming the plant species and to Deputy Director, Botanical Survey of India, Port Blair, for encouragement.

September 27, 1990. S.K. SRIVASTAVA

35. NEW RECORD OF *SCHEFFLERA* J.R. & G. FORST (ARALIACEAE) FROM INDIA

(With a text-figure)

During the course of plant collection in the forest areas in Great Nicobar Islands, I collected plant specimens identified as *Schefflera* of Araliaceae, from the 38 km East-West Road of Campbell Bay. On critical examination at Central National Herbarium it was found that the species compares well with one Javanese specimen designated as *Heptapleurum longifolia* Seem.

Frodin (1975) and Philipson (1979) treated the genus *Heptapleurum* Gaertn. under *Schefflera* J.R. & G. Forst. *Schefflera* J.R. & G. Forst *nom. cons.* (= *Heptapleurum* Gaertn.) is represented by 200 species in the world. In India it is represented by *c.* 15 species (Santapau and Henry 1973).

Hooker (1879) recorded 15 species of *Heptapleurum* Gaertn. Of these, 9 are reported from various parts of India, mainly north-west Himalaya, Khasi hills and Nilgiris. They also occur in Bhutan, Burma, Malaysia and Sri Lanka. Two species, viz. *Schefflera elliptica* (Bl.) Harms and *S. venulosa* (W. & A.) Harms are known to occur in the Andaman and Nicobar islands (Vasudeva Rao 1986).

Critical study of the specimen and literature reveals that the present collection is *Schefflera longifolia* (Bl.) Vig. – a Javanese species hitherto not recorded from India. Therefore, it is reported here with nomenclatural citation, detailed description and illustrations.

Schefflera longifolia (Bl.) Viguier in Ann. Sci. Nat. ser. 9, 9: 356. 1909. *Sciadophyllum longifolium* Bl. Bijdr. 876. 1826. *Heptapleurum longifolium* Seem. in Jour. Bot. 3: 79. 1865. (Fig. 1).

An evergreen tree, *c.* 8-10 m tall, younger parts covered with a fluccose scurfy or tawny tomentum. Leaves digitately 5-7 foliolate; petioles 80 cm long, nearly glabrous, smooth, very finely ribbed, base spathaceous with numerous warted growths; leaflets 28–35 x 8–13 cm, ovate, oblong to oblong-ovate, coriaceous, glaucous beneath, broadly serrate on margin, acuminate, rounded or obtuse at base; petiolules 5.5-6.5 cm long with spathulate base; lateral nerves 15-18 pairs, prominently raised beneath.

Inflorescence terminal, umbel shorter than leaf.

Fig. 1. *Schefflera longifolia* (Bl.) Vig.
1. Habit (a twig), 2. Inflorescence, 3. Bracts, 4. Umbel, 5. Flower, 6. Flower showing attachment of stamens. 7. Stamen.

Branching of stem in (Left) *Borassus flabellifer*. (Right) *Cocos nucifera*.

Panicle 35-50 cm long, tawny-tomentose, umbel numerous, 1.5-2 cm in diameter, comprising 25-35 flowers. Peduncle 2.5-3.5 cm long; bracts 0.6-0.8 cm long, extra-axillary, boat-shaped, scurfy, white to dull brownish. Flowers 0.5-0.6 cm long, numerous; white to dull brownish. Pedicels 0.4-0.7 cm long, scurfy. Calyx poorly developed or nearly absent.

Petals valvate in bud, nearly 8-lobed, ovate, fused petals forming an operculum on the disc. Stamens 8, 0.1-0.15 cm, arranged alternately, with petals, dorsifixed; filaments slightly curved at apex and broader at base. Ovary covered by the disc. Fruit not seen.

Flowering: December-January.

Distribution: Malaysia: Java. India: south Nicobar.

Exsicc.: Andaman and Nicobar Islands: Great Nicobar, 38 km East-West Road, along roadside, 12 Jan. 1990, S.K. Srivastava 14940 (*PBL*)

It occurs in mixed evergreen forest. Occasional.

I am grateful to Dr. B.D. Sharma, Additional Director-in-charge, Botanical Survey of India, for facilities, Dr. J.L. Ellis, Deputy Director, BSI Port Blair, for constant encouragement and also to forest authorities at Great Nicobar, specially A. Guha, officiating Divisional Forest Officer, for providing all facilities during the survey.

June 29, 1990. S.K. SRIVASTAVA

REFERENCES

FRODIN, D.G. (1975): Complex of *Cephaloschefflera* in *Schefflera* (Araliaceae). *J. Arn. Arb. 56:* 427-448.

HOOKER, J.D. (1879): *Heptapleurum* Gaertn. The Flora of British India *2*: 727 – 731. L. Reeve & Co., London.

PHILIPSON, W.R. (1979): Araliaceae. *In:* C.G.G.J. Van Steenis (Ed.) Flora Malesiana 1, *9* (1) : 1-105.

SANTAPAU, H. & HENRY, A.N. (1973): A Dictionary of the Flowering Plants in India. 153 CSIR, New Delhi.

VASUDEVA RAO, M.K. (1986): A preliminary report on the Angiosperms of Andaman and Nicobar Islands. *Jour. Econ. Tax. Bot. 8(1):* 107-184.

36. OCCURRENCE OF BRANCHED *BORASSUS FLABELLIFER* L. AND *COCOS NUCIFERA* L. IN PONDICHERRY

(With a plate)

The family Arecaceae is represented by 63 indigenous palms from India (PALMS OF INDIA, Mahabale, T.S. 1982). There is no regular branching of stem in palms except in the genus *Hyphaene*. However, occasional cases of branching have been reported in the following species: *Phoenix sylvestris, P. dactylifera, P. roebelinii, Borassus flabellifer, Arenga* sp., *Sabal palmetto, Copernicia cerifera, Areca catechu* and *Cocos nucifera* (Mahabale 1982). There are only a few reports of branching of palmyra and coconut trees (Mahabale 1982). They include a palmyra palm with five branches from Coimbatore district of Tamil Nadu and a branched palmyra palm from Surat and branched coconut palms from Malabar (branched twice), Car Nicobar island and Surat (with four branches). The present communication relates to the occurrence of such branched trees in Pondicherry.

During routine plant collection trips in and around Pondicherry, a peculiar male palmyra palm with as many as 22 branches was seen on the left side of Pondicherry Marakkanam main road after Kottakuppam. Out of the total of 22 branches, 14 were intact and scars were seen for the other eight branches which were cut or damaged.

The most interesting aspect of this tree is that one of these intact branches in turn bears four branches. All the undamaged branches are healthy and bear flowers during season. This palm is shorter (by a few feet) than the other normal palm. The thickness of the main trunk is similar to that of a normal palm, but the branches are slightly thinner (Plate 1).

Similarly, a coconut palm with two branches was located in a suburban grove at the outskirts of Pondicherry near Muthialpet. Here the branches are slightly thinner than the main trunk and bear fruits (Plate 1).

The causes of branching in the palms are not definitely known. However, it is attributed to destruction of apical bud, injury to growing point due to forest fires and insect bites (Mahabale 1982) or strokes of lightning which lead to splitting of terminal bud (THE NATURAL HISTORY OF PALMS, Corner,

E.J.H. 1966).

In the present case branching is presumed to be due to injury to apical bud caused by strong winds, as these plants grow near the sea shore on the east coast.

V. RAMASSAMY
B. KANNABIRAN

October 29, 1990

37. NEW RECORDS OF THREE GRASSES AND ONE SEDGE FROM ORISSA

During the course of a study on the flora of Keonjhar district of Orissa, a number of plants previously not reported from the state were found. The present report records four such species, three of Poaceae and one of Cyperaceae: *Scirpus roylei* (Nees) Parker, *Digitaria setigera* Roth, *Eragrostis nigra* Nees *ex* Steud. and *Panicum humidorum* Buch.-Ham. *ex* Hook. f. All these are new records for Orissa. The taxa are enumerated with nomenclatural citations, brief descriptions and distributional notes.

CYPERACEAE

Scirpus roylei (Nees) Parker in Duthie, Fl. Upper Gang. Pl., 3: 361.1929; Shah in J. Bombay nat. Hist. Soc., 66: 233. 1969. *Isolepis roylei* Nees in Wt. Contrib., 107. 1834. *Scirpus quinquefarius* Ham. *ex* Boeck. in Linnaea, 36: 701. 1869-70; Clarke in Hook. f. Fl. Brit. India, 6 : 657. 1893; Prain, Beng. Pl., 2: 1160. 1903.

Wild erect sedges. Stem slender, terete, transversely septate when dry; sheath mouth oblique, truncate. Leaves almost nil. Inflorescence of spikelet in dense head; spikelets ovoid-oblong, obtuse, slightly compressed, brown shining; glumes inflated in fruit, elliptic-lanceolate, membranous, acute to mucronate, apex shortly recurved, keeled, tapering at base; stamens 3, 5-6 mm long; anthers linear, obtuse; ovary obovoid; styles 3 fid, 2-3 mm long; stigma 3. Fruits nut, obovoid, trigonous, apiculate.

Flowering and fruiting: November-January.

Occurrence: Common.

Locality: Pithogora, 20 Dec. 1983, *Mondal,* 399, 964.

The earlier reports of the species have been from Bihar, Assam, and Madhya Pradesh. So the present report in Orissa is a new record for the state and extension of its distribution towards the southern part of India.

POACEAE

Digitaria setigera Roth. in Roem. & Schult. Syst. Veg., 2: 474. 1871; Henr. Monogr. Digit., 684. 1950; Bor, Webbia, 11: 344. 1955 & Grass. Burma, Ceylon, India and Pakistan, 305. 1960. *Paspalum sanguinale* Lamk. var *extensum* Hook. f. in Fl. Brit. India, 7: 15. 1897; Fischer, Fl. Madras, 3 : 1764. 1934.

Annual, long erect grass. Stem slender, glabrous. Leaves linear, acute, rounded at base, flat, margin scabrous, 110-112 mm long, 4-5 mm wide; sheaths long; rachis slender, triquetrous, narrowly winged. Spikelets 1 floret oblong, acute, bearded, 3-4 mm long, 0.5-0.8 mm wide; glume 1 minute, scaly; glume 2 membranous, about half as long as lower lemma; lemma ovate oblong, acute, membranous, 3-5 nerved, palea subchartaceous.

Flowering and fruiting: October-November.

Occurrence: Common.

Locality: Silua village, 13 Aug. 1983, *Mondal,* 20.

Though this taxa is widespread in all the warmer states of India, it was not earlier reported from Orissa. So the present collection in Keonjhar is a new record for the state.

Eragrostis nigra Nees ex Steud., Syn. pl. Glum., 1: 267. 1854; Stapf in Hook. f., Fl. Brit. India. 7: 324. 1897; Fischer, Fl. Madras, 3 : 1827. 1934; Bor, Grass. Burma, Ceylon, India and Pakistan, 511. 1960.

Perennial wild erect grass, leafy at base. Leaves flat at base, elongate above; 60-200 mm long, 1-2 mm wide; mouth of sheaths bearded; basal sheaths narrow, terete. Inflorescence panicle, very long, up to 60 cm broad, branches simple below; pedicels longer than spikelets. Spikelets olive-grey, linear to oblong, 3-9 flowered, 5-6 mm long; glume 1 and 2 membranous, subequal, acuminate, keels scabrid; lemma ovate, acute, 0.8-1 mm long; palea obtuse, denticulate, persistent; stamens 3. Caryopsis dorsally slightly grooved.

Flowering and fruiting: June-September.

Occurrence: Rare.

Locality: Silua village, 13 Aug. 1983, *Mondal,* 17.

The present collection establishes the continuous distribution of the taxon from north to south India, i.e. Sikkim, Assam, Meghalaya, Bihar, Orissa, Andhra Pradesh, Tamil Nadu, Kerala,

Karnataka and Maharashtra.

Panicum humidorum Buch.-Ham. *ex* Hook. f. Fl. Brit. India, 7: 53. 1897; Bor, Grass. Burma, Ceylon, India and Pakistan, 326. 1960.

Perennial, wild, slender grass. Leaves linear, shortly cordate at base, 8-10 mm wide. Inflorescence panicle, large; pedicels capillary, smooth; spikelets ellipsoid, obtuse, glabrous, 0.8-1 mm long; glume 1 obtuse, 3-nerved, shorter; glume 2 and lemma obscurely 3-nerved. In lower florets lemma epaleate. Upper florets hermaphrodite; lemma ovate, 1-1.2 mm long, smooth; palea as long as lemma.

Flowering and fruiting: October-December.

Occurrence: Rare.

Locality: Hatgarh forest near Salindi river, 12 Dec. 1984, *Mondal*, 827.

The taxon has been recorded only from Assam, Meghalaya and Bangladesh. The present collection forms a new record for Orissa.

PAPIA MONDAL
P.K. MUKHERJEE

June 7, 1990

38. TWO NEW PLANT RECORDS FROM ANDHRA PRADESH

(With two text-figures)

While studying the flora of Nizamabad district in Andhra Pradesh two rare plants were collected. The species were identified as *Elytrophorus spicatus* (Willd.) A. Camus, and *Rumex dentatus* L. which have not been reported earlier from Andhra Pradesh. Illustrations and distinguishing characters are given for each of these species to facilitate their easy identification. The citation and comprehensive distribution data are included.

Elytrophorus spicatus (Willd.) A. Camus in Lecomte, Fl. Gen. Indochine 7 : 547. 1923; Gamble 1843 (1275); Bor 493. *Dactylis spicata* Willd. in Ges. Naturf. Freunde Berlin Neue Schriften 3:416. 1801. *Elytrophorus articulatus* Beauv., Ess. Agrost. 67. t.

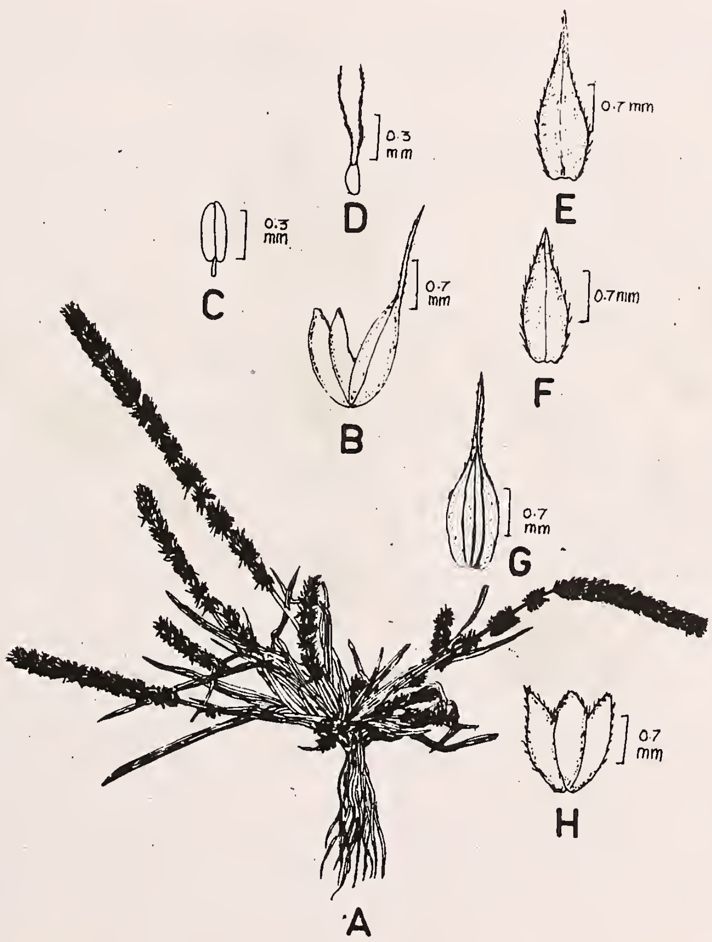


Fig. 1. *Elytrophorus spicatus* (Willd.) A. Camus
A. Habit, B. Spikelet, C. Stamen, D. Pistil, E. Upper glume, F. Lower glume, G. Lemma, H. Palea.

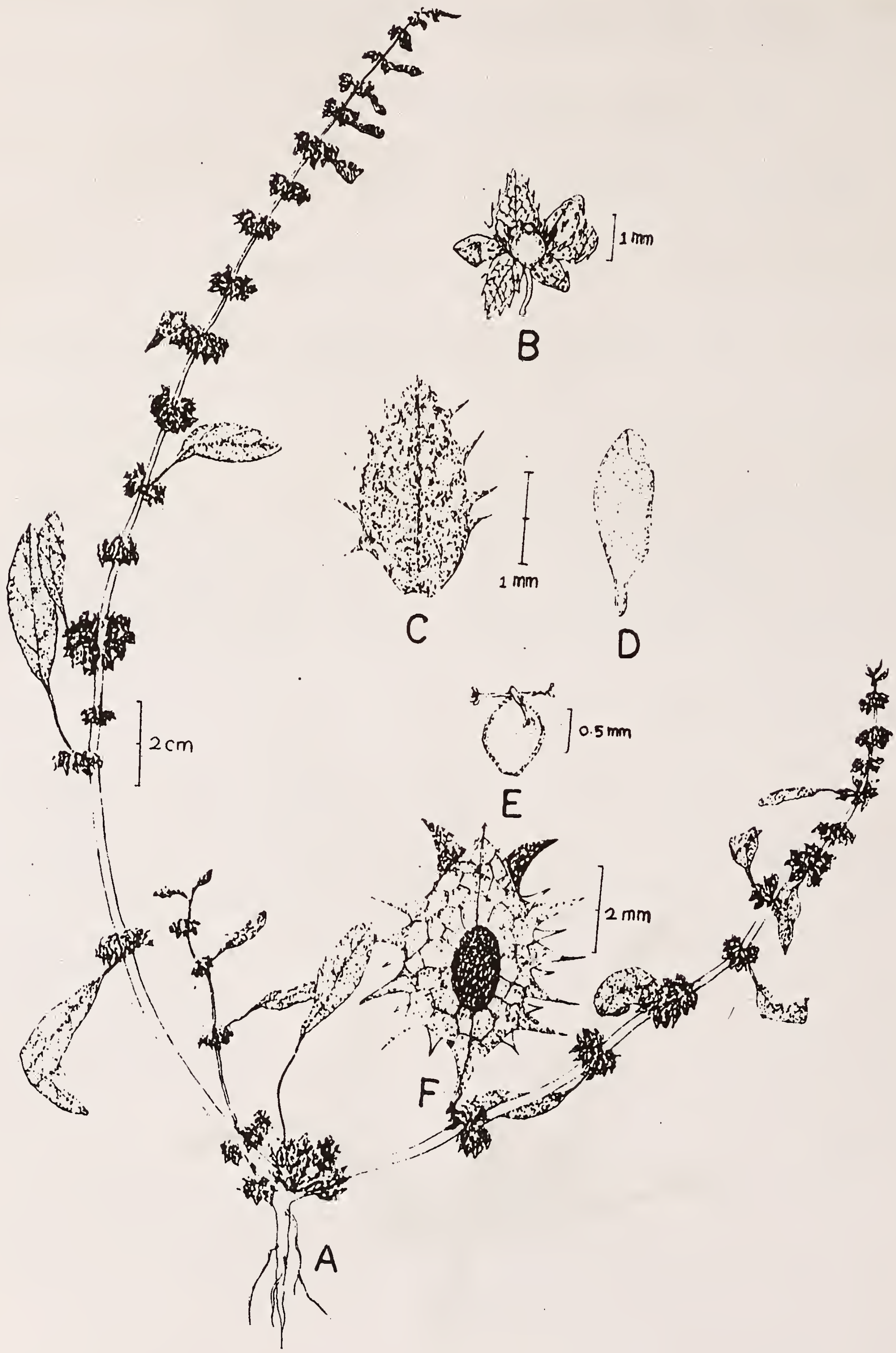


Fig. 2. *Rumex dentatus* L.
A. Habit, B. Flower, C. Inner perianth segment, D. Outer perianth segment, E. Pistil, F. Nut.

14. 1812; FBI 7:306; Bombay Grasses 276, t. 188. (Fig.1).

Annual; culms tufted, to 20 cm. Leaves linear, 2–7 x 0.2–0.3 cm, subglabrous, acuminate; sheaths to 2 cm. Inflorescence composed of globose clusters of minute sessile spikelets crowded together in 5-15 cm long continuous or interrupted catkin-like spike. Spikelets 4-6-flowered; glumes subequal, aristate, 1-nerved, 1-keeled; lemmas aristate, 3-nerved; paleas winged. Caryopsis fusiform.

Flowering and fruiting: July-March.

Distribution: Nizamabad: occasional in moist places and fields. INDIA: more or less throughout India.

Specimens examined: Nagaram, *BR* 9710

Rumex dentatus L., Mant. Pl. 2 : 226. 1771; FBI 5:59. (Fig.2).

Annual erect deep-rooted herb, up to 50 cm tall; branches all arising from the rootstock, glabrous. Leaves radical and cauline, oblong-lanceolate, 1–6 x 0.5–1.2 cm, glabrous, base rounded or acute, apex rounded, margin entire or obscurely-crenate; petiole to 5 cm. Flowers in leafy or leafless whorls. Perianth segments 6, inner segments enlarged in fruit, reticulately veined, with an ovoid-oblong tubercle at back and with pectinate margins. Nuts trigonous, winged, to 0.2 x 0.1 cm.

Flowering and fruiting: September-February.

Distribution: Nizamabad: rare along river and canal banks. INDIA: Bengal, Bihar, Assam and western peninsula.

Specimens examined: Kandakurthi (Godavari river banks), *BR* 7263.

Gamble reported one wild species of *Rumex* L. from Andhra Pradesh, viz. *Rumex nigricans* Hook. f. (distribution: North Circars). *Rumex dentatus* differs from *R. nigricans* in having inner fruiting-perianth with broad much-toothed wings.

We are grateful to Dr. Vivekananthan and Dr. P.V. Sreekumar of BSI, SC, Coimbatore for their help in identifications.

B. RAVI PRASADA RAO
T. PULLAIAH
September 27, 1990. K. HANUMANTHAPPA

39. NEW PLANT RECORDS FROM ANDAMAN AND NICOBAR ISLANDS
(With a text-figure)

Plant collections made during the botanical exploration in Interview Island (North Andamans) and studies on the Icacinaceae and Celastraceae of the Andaman and Nicobar islands have resulted in locating four plants, viz. *Miliusa globosa* (DC.) Panigr. & Mishra, *Polyalthia rufescens* Hook. f. & Thoms., *Gomphandra tetrandra* (Wall.) Sleum. and *Salacia verrucosa* Wight not known earlier from these islands, which are being reported here. Parkinson (1923) and Vasudeva Rao (1986) have not reported them.

The herbarium specimens have been deposited in the herbarium of Andaman and Nicobar Circle, Botanical Survey of India, Port Blair (PBL). They are enumerated below along with brief descriptions.

ANNONACEAE

Miliusa globosa (DC.) Panigr. & Mishra in Taxon 33: 713. 1984. *Guatteria globosa* DC., Mem. Soc. Phys. Hist. Natur. Genev. 5: 41 ("43") (Preprint? 1831); et period. edit.: (?) 218, before 21 Nov. 1832. *Miliusa roxburghiana* Hook. f. & Thoms., Fl. Ind. 150. 1855 & in Hook f., Fl. Brit. India 1: 87. 1872; King in Ann. Roy. Bot. Gard. Calcutta 4:155, t. 189 B. 1893; Sinclair in Gard. Bull. Singapore 14: 46. 1953; Debika Das in Bull. Bot. Surv. India 5: 46. 1963, *nom. illeg.*

Shrubs, *c.* 4.5 m high. Leaves up to 14 x 5.5 cm, oblong to oblong-lanceolate or oblanceolate, acuminate, rounded; petioles obsolete. Buds *c.* 0.3 cm long, green, pedicels 0.6 cm long. Carpels *c.* 0.4 cm long, ovoid or pisiform.

Specimen examined: Andaman Islands, Interview Island, 6 March 1990, *P. Lakshminarasimhan* 15135.

Debika Das (l.c.) reported this species from Sikkim, Mungpoo, Khasia hills, Assam, Chittagong, Sylhet, Bengal and Naga hills. Panigrahi and Mishra (*l.c.*) give the distribution of this species as Burma, Bhutan, Bangladesh, India (eastern India) and Nepal.

Polyalthia rufescens Hook. f. & Thoms. in Hook. f., Fl. Brit. India 1: 66. 1872; King in Ann. Roy. Bot. Gard. Calcutta 4: 83, t. 116. 1893; Debika Das in Bull. Bot. Surv. India 5: 43. 1963.

Shrubs, *c.* 3 m high. Leaves up to 16 x 6.4 cm,

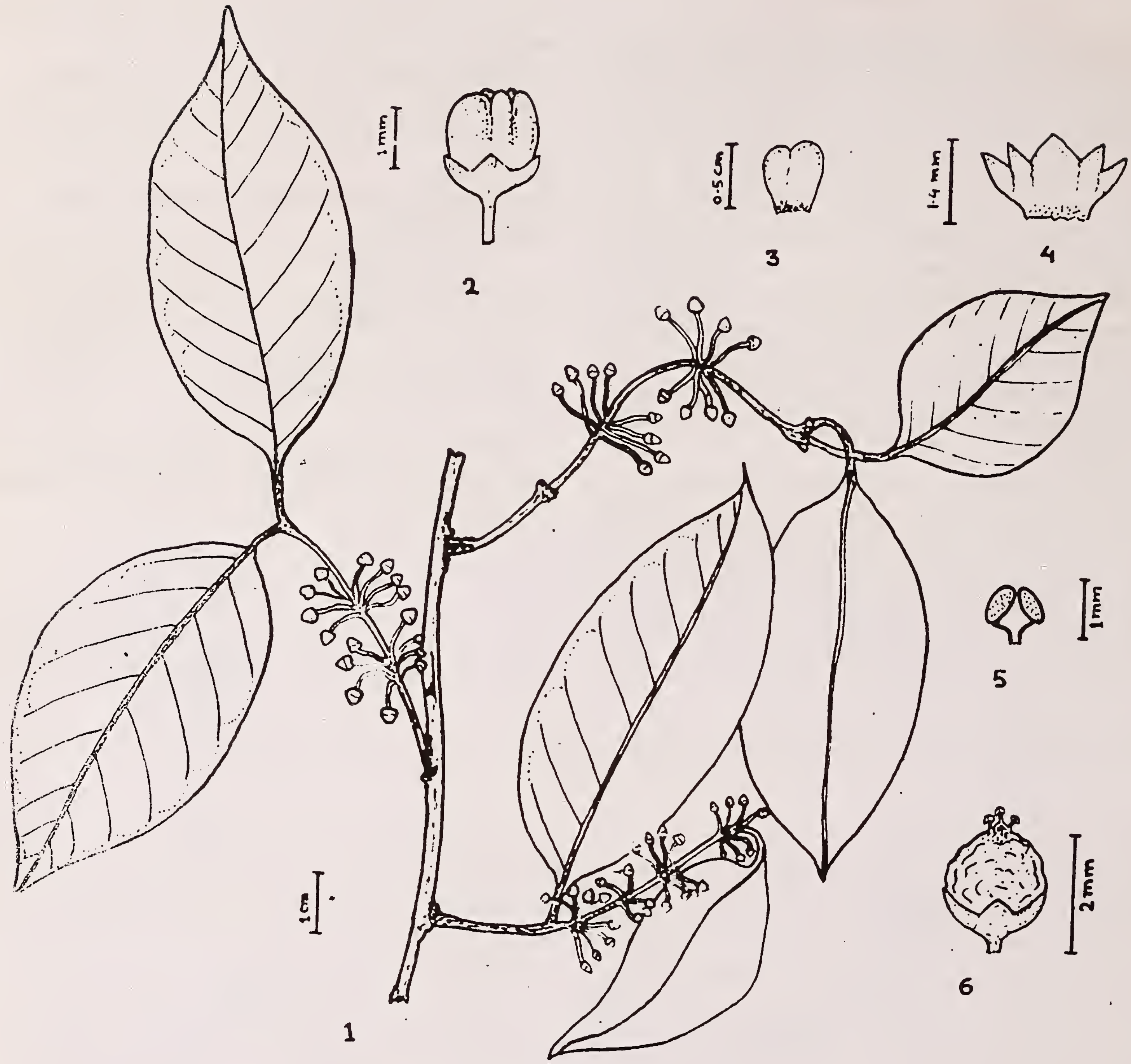


Fig. 1. *Salacia verrucosa* Wight.
1. Habit, 2. Flower, 3. Petal, 4. Calyx (cut open), 5. Stamen, 6. Disc, showing attachment of stamens.

narrow-oblong, elliptic-lanceolate or oblanceolate, acuminate, rounded; petioles c. 0.2 cm long. Buds c. 0.3 cm long, orange, pedicels c. 1 cm long. Carpels c. 0.4 cm in diameter, globose.

Specimen examined: Andaman Islands, Interview Island, 7 March 1990, *P. Lakshminarasimhan* 15168.

Debika Das (l.c.) reported this species from Cochin and Travancore.

ICACINACEAE

Gomphandra tetrandra (Wall.) Sleum. in Notizbl. Berl.-Dahl. 15: 238. 1940 & in Blumea 17: 204. 1969. *Lasianthera tetrandra* Wall. in Roxb., Fl. Ind. 2: 328. 1824. *Gomphandra axillaris* Wall. ex Voigt, Hort. Suburb. Calc. 31. 1845 *nom. illeg.*; Bedd., Fl. Sylv. 3: t. 61. descr. 1876; Mast. in Hook. f., Fl. Brit. India 1: 586. 1875.

Trees, 15-18 m high. Leaves up to 15.8 x 6.3 cm, elliptic to oblanceolate, submembranous, acuminate, cuneate; petioles up to 1.2 cm long. Cymes axillary, puberulous, dichotomously branched, up to 2 cm long. Flowers c. 0.3 cm long.

Specimen examined: South Nicobars, Laful forest, Great Nicobar Island, 16 May 1981, *R.P. Dwivedi*

8534. Frequent in hill forests near ditches.

Sleumer (1969) reported this species from Sri Lanka, India (western peninsula from the Concan southwards; Nilgiris; Madras Presidency, etc. – Assam and Khasia), Burma, Indochina, China and Thailand.

CELASTRACEAE

Salacia verrucosa Wight, Ill. 1: 134. 1840; Laws. in Hook. f., Fl. Brit. India 1: 628. 1875; Ding Hou in Steenis, Fl. Males. 1, 6: 414, fig. 35. 1964. (Fig. 1).

Scandent shrubs. Leaves up to 8.5 x 4.5 cm, elliptic or ovate-elliptic, chartaceous to subcoriaceous, acuminate or rarely cuspidate, cuneate or rounded; petioles up to 1.2 cm long. Flowers *c.* 0.2 cm long, green, in fascicles.

Specimen examined: North Nicobars, Malacca, Car Nicobar, 11 August 1973, *N.P. Balakrishnan* 433. Common in coastal forests.

Ding Hou (1964) reported this species from India (Assam and Khasia hills), Thailand, Burma, Indochina and Malesia. Raju (1965) gives the distribution of this species in India as Assam; Andamans – *Griffith* 888. But Griffith's collection 888 (CAL) is from Mergui (Malay peninsula). However, there is a collection of *Helfer 889* (CAL) without exact locality and labelled 'Tenasserim and Andamans' but there is confusion regarding the exact locality. Helfer was murdered by the aborigines on the North Andamans and his collections were unfortunately mixed up with his Tenasserim plants, and hence all have been labelled 'Tenasserim and Andamans'.

We are thankful to Dr. B.D. Sharma, Director, Botanical Survey of India, Calcutta, for facilities; to Dr. N.P. Singh, Regional Botanist, Royal Botanic Gardens, Kew, for confirming the identity of *Salacia verrucosa;* to Dr. D. Mitra, Scientist-SD, Botanical Survey of India, Central National Herbarium, Howrah, for confirming the identities of Annonaceae specimen and to Dr. J.L. Ellis, Deputy Director, Botanical Survey of India, Andaman and Nicobar Circle, Port Blair, for encouragement.

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November 1, 1990

REFERENCES

DEBIKA DAS (1963): Enumeration of Indian Flowering Plants - VI by S.K. Mukherjee – Annonaceae. *Bull. Bot. Surv. India 5:* 39-47.

DING HOU (1964): Celastraceae-II. *In:* C.G.G.J. Van Steenis (Ed.), Flora Malesiana 1, *6:* 389-421. P. Noordhoff Ltd.

PANIGRAHI, G. & MISHRA, S.C. (1984): *Miliusa globosa* comb. nov. for *M. roxburghiana* (Annonaceae). *Taxon 33:* 713-714.

PARKINSON, C.E. (1923): A Forest Flora of the Andaman Islands. Government Central Press, Simla.

RAJU, D.C.S. (1965): Enumeration of the Indian species of Hippocrateaceae. *J. Biol. Sci. 8(2):* 55-59.

SLEUMER, H. (1969): Materials towards the knowledge of the Icacinaceae of Asia, Malesia and adjacent areas. *Blumea 17:* 181-263.

VASUDEVA RAO, M.K. (1986): A preliminary report of the angiosperms of Andaman-Nicobar islands *J. Econ. Tax. Bot. 8:* 107-184.

40. NEW PLANT RECORDS FOR ORISSA

Out of 32 vegetational types as mentioned by Champion and Seth (1968), littoral and swamp forests are unique to the state of Orissa. However, these have not been properly botanised by Haines (1921-25) and Mooney (1950). During the recent floristic studies in the mangrove forests of Orissa, three species proved to be new records for the state. Correct nomenclature, short diagnostic characters, locality of collection, field number, notes on ecology and distribution have been provided.

Blumea aurita (Linn.f.) DC. in Wight, contrib. 16: 1834; Grierson in Dassny. *et* Fosb. Fl. Ceylon 1: 168. 1980. *Conyza aurita* Linn. f. Suppl. 367. 1781. *Laggera aurita* (Linn. f.) Benth. ex C.B. Clarke, Comp. Ind. 92. 1876; Haines, Bot. Bihar and Orissa 2: 490.1961. (Asteraceae).

Strongly scented glandular herbs. Branching from base. Stem with decurrent leaf bases. Capitula numerous, ovoid, in lax corymbose panicle. Corolla purple.

Flowering and fruiting: December-March.
Specimen examined: Bhitarkanika (Dangmal rest house), *H.N. Subudhi 6679.*
Illustration: Maheswari, Illus. Fl. Delhi. f. 107. 1966.
Distribution: India, Burma, Trop. Africa.
Ecology: Growing in saline marshy places not under direct spell of inundation.

Haines (l.c.) reported this species in his treatise without citing precise locality for Orissa.

Ipomoea campanulata Linn. Sp. Pl. 160. 1753; Austin in Dassny. *et* Fosb. Revs. Handb. Fl. Ceylon. 1: 327. 1980. *Impomoea illustris* (Clarke) Prain, Beng. Pl. 2: 735. 1903. *Ipomoea campanulata* var. *illustris* Clarke in Hook.f. Fl. Br. Ind. 4: 211. 1883. (Convolvulaceae).

Robust twiner. Leaves ovate, cordate, 10-15 nerved, entire; lateral nerves not parallel. Sepals obtuse, unequal, glabrous. Corolla funnel shaped, about 10 cm, reddish purple with darker centre, pale outside. Stamens included. Ovary glabrous.

Flowering and fruiting: November-February.
Specimen examined: Bhitarkanika (Khola creek), *H.N. Subudhi,* 13630; *B.P. Choudhury,* 16009.
Distribution: INDIA: Sundarban, Andaman, west coast. Elsewhere: Sri Lanka, Malaysia.
Ecology: This robust climber is gregarious among the mangrove shrubs growing in the fringes of creeks where water salinity is low.

Hygrophila erecta (Burm.f.) Hochr. Candollea 5: 230. 1934; Manilal *et* Sivarajan, Fl. Calicut, 225. 1982. *Ruellia erecta* Burm.f. Fl. Ind. 135. 1784. *Hygrophila quadrivalvis* Nees in Wall. Pl. As. Rar. 3:80.1832; Haines, Bot. Bihar and Orissa 2: 703. 1961. (Acanthaceae).

Erect herbs. Leaves larger (2-4 x 0.6-1 cm). Flowers in axillillary whorls; bracteole obtuse, strigose. Calyx with strigose hairs. Corolla purplish blue. Capsule pubescent.

Flowering and fruiting: November-February.
Specimen examined: Bhitarkanika (swampy areas at the end of Suajhor creeks), *H.N. Subudhi* 13612; *B.P. Choudhury* 16021.
Distribution: INDIA: Bengal, Tamil Nadu, west coast. Elsewhere: Sri Lanka, India to Malacca.
Ecology: This taxon mostly colonises the muddy beds of the creeks.

H.N. SUBUDHI
B.P. CHOUDHURY
B.C. ACHARYA

September 11, 1990

REFERENCES

CHAMPION, H.G. & SETH, S.K. (1968): A revised survey of the forest types of India. New Delhi.
HAINES, H.H. (1921-25): The Botany of Bihar and Orissa. 6 parts. London.
MOONEY, H.F. (1950): Supplement to the botany of Bihar and Orissa. Catholic Press, Ranchi.

41. ADDITIONS TO THE BRYOFLORA OF ANDAMAN AND NICOBAR ISLANDS

The Andaman and Nicobar islands are experiencing rapid growth of population and human settlements due to rapid all-round development. This has affected both the physical environment and the biotic components. The effect of the intense biotic stress on the quality and quantity of the vegetal cover of Andaman and Nicobar islands needs a thorough survey. During the course of a survey of the endemic flora of these islands, a number of plants which were not previously known to occur here were discovered. This note deals with some mosses collected from south Andaman which are not reported from these islands so far. The bryoflora of these islands remains unexplored. However, some sporadic surveys have been done by Thothathri (1960, 1962), Lal (1980), Udar and Kumar (1983), Nath (1984) and Joshi *et al.* (1989). 13 endemic species have been reported so far from these islands (Chopra 1975). The bryoflora is very interesting, and requires more attention and a thorough survey.

Octoblepharum albidum Hedw., Sps. Musc. 50, 1801.

The plant (class Peristomiopsida, order Dicranales and family Leucobryaceae) is very small, growing in velvety green patches. It is also reported from Kumaon, Sikkim. south India (Kodaikanal), Concan, Nepal, Burma, Ceylon, Indo-Malayan region, Philippines. Australia, Pacific Ocean islands, Sino Japanese region, Africa, Madagascar, North and South America.

The average height of the plant is 12 mm, unbranched. Leaves linear, sessile, opposite but appearing as whorl arrangement, no midvein, apex acute, margin entire, length of the leaf 7 mm, breadth 1 mm. Rhizoids growing in bunches, unbranched. Septate and branched rhizoids were seen very rarely. Calyptra (30 mm long) is longer than capsule (26.6 mm).

The plant was not very common and was located along the bank of nullah and on slopes near Shippighat during July to November. According to the available literature no other species of the genus has been reported from India. Therefore, it appears to be a monotypic genus.

Garckea C. Muell, Bot. Ztg. Regensburg 3: 865, 1845.

This genus belongs to the musci (Muscophytina), class Peristomiopsida, sub-class Bryidae, order Dicranales and family Ditrichaceae. The genus contains five species, which (other than *G. abbreviata*) resemble *G. phascoides* in habit. *G. abbreviata* differs from *G. phascoides* on the characters of the capsule only, and is endemic to central Africa, which seems to be the centre of origin of the genus.

Garckea phascoides (Hook.) C. Muell, I.C. Dicianum, 1830 is also distributed in Khasi hills, West Bengal, south India, Nepal, Bhutan, Burma, Tonkin, Malaysia, Australia, Oceanic Island, China, Japan, Madagascar and Panama.

The plant is comparatively larger, 17 mm in length. Stem erect, 1 mm thick, leaf lanceolate, lower smaller alternate in lower region, upper ones aggregated into bunch at the apex, margin entire, apex acute, length of the leaf 12.3 mm, breadth 2.2 mm, midrib absent. Rhizoids growing in a bunch at the base, unbranched, septate, septa obliquely placed. Capsule 31.6 mm long, and clyptra 14 mm long. Plant is localised in a few areas only. Some patches of the plant were seen only at one place on the bank of a drain below the slope on the way to Chowldhari (south Andaman) during July to November. Other species are *G. comosa* (Doz and Molk) Wijk and Marg. Taxon 9:190, 1960 and *G. abbreviata* Dix and P. Vard. Archs. Bot. Bull. news 1 (8-9): 16, 1927. These are reported from Mangalore.

I am grateful to the Ministry of Environment and Forests, Govt. of India, for financial support and the Hattori Laboratories, Japan, for the identification.

September 11, 1990

A.R.P. SINHA

REFERENCES

CHOPRA, R.S. (1975): Taxonomy of Indian Mosses. Botanical monograph No. 10. C.S.I.R., New Delhi.

JOSHI, D.Y., WANI, D.S. & CHAVAN, S.J. (1989): Studies on the Hepatic flora of Andaman Islands (India)-1. *Ad. Plant Sci. 2(2):* 169-177.

LAL, J. (1980): *Colura ari* Steph. (Hepaticae) from Andaman – a new record for India. *Bull. Bot. surv. India 22:* 207-209.

NATH, V. (1984): Studies on the genus *Frullania* Raddi. from Andaman. Abstracts J.I.B.S. 7th all India conf. 63 suppl. IV 2.

THOTHATHRI, K. (1960): Studies on the flora of Andaman and Nicobar Islands. *Bull Bot. surv. India 2(3-4):* 357-373.

THOTHATHRI, K. (1962): Contribution to the Andaman and Nicobar Islands. *Bull. Bot. surv. India 4(1-4):* 281-296.

UDAR, R. & KUMAR ADARSH (1983): Studies in Indian Jungermanniaceae II —*Jungermannia* (*Pleactocolea*) *tetragona* Lindenb. from Andaman Islands with a note on its distribution in India. *Jour. Indian Bot. Soc. 62:* 357-360.

ERRATA

Vol. 88(1): Reviews, p. 106

For *Biophytum sensitivum* DC. (Linn.) read *Biophytum sensitivum* (Linn.) DC.
For *Blumea lacera* DC. (Burm.) read *Blumea lacera* (Burm.) DC.
For *Blumea laciniata* DC. (Roxb.) read *Blumea laciniata* (Roxb.) DC.
For *Barringtonia acutangula* (Linn.) read *Barringtonia acutangula* Linn.

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NEW EVIDENCE FOR HYBRIDIZATION IN *PRESBYTIS JOHNII* AND *PRESBYTIS ENTELLUS*[1]

G. HOHMANN[2]

(*With a plate*)

The occurrence of langurs with an aberrant coat colour has been reported for different places in the Western Ghats, south India. Analyses of loud calls of a so-called 'brown langur' male revealed a similar physical structure to equivalent vocal patterns of both Nilgiri langur *Presbytis johnii* and common langur *P. entellus = cxxxxxxxxcx* : The timing of the phrases as well as the range and modulation of the basic frequency of the units resembles the loud call of *P. entellus.* The composition of the loud call bouts, consisting of several phrases with different vocal patterns and a specific expression movement during the performance, are characteristic features of loud call displays of *Presbytis johnii.* These findings support the hypothesis that the aberrant coloured langurs are hybrids of Presbytis johnii and *P. entellus.* Recent observations of the relationship between these species show various forms of interspecific associations. Males of both species join groups of the other species. The intruder can be a single male or (in one case) an all-male group. The relation can be affable, mutual tolerance or one-sided affinity. The absence of hybrids in a population for which long-standing association has been documented may indicate differences in behavioural strategies of these species.

INTRODUCTION

The Nilgiri langur *Presbytis johnii* is the only langur species endemic to India. Its distribution is restricted to natural forests in the southern part of the Western Ghats in south India (Kurup 1975, Oates 1979). In contrast to its closest relative, the purple face leaf monkey *Presbytis senex* of Sri Lanka, where several subspecies are distinguished (Napier and Napier 1967), the morphological character of the Nilgiri langur is homogeneous throughout the whole range of distribution. Trunk, tail and limbs are black, the head pilose is red to brown and wig-shaped.

However, Nilgiri langurs with a different coloration have been reported occasionally. The first information of Nilgiri langurs with an atypical coat colour is contained in reports about skins collected for the British Museum (Anonymous 1955). More recently, Oates (1982) and Hohmann and Herzog (1985) observed so-called 'brown langurs' in the area of Agastiamalai and Anamalai respectively. In both cases, the brown individuals lived together with black coloured Nilgiri langurs, forming mixed groups.

The common characteristics of the brown animals of Anamalai (11 individuals in 3 different groups) were: Trunk and proximal parts of arms and legs brown. Tail, hands and feet, and the distal parts of the limbs were blackish in colour. All buff parts were black. The head pilose was cream coloured, hood-shaped, and closed below the lower jaw.

The occurrence of common langurs *Presbytis entellus* in adjacent ranges and the temporary

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TABLE 1
PHYSICAL CHARACTERISTICS OF LOUD CALLS OF *Presbytis johnii, P. entellus,* AND A BROWN LANGUR MALE

	Presbytis johnii	Brown langur	*Presbytis entellus*
Number of units per phrase	7-18	2-9	2-6
Basic frequency, Hz	200-350	150-250	150-250
Frequency range, Hz	330-8000	150-5000	150-5000
Length of unit, sec.	0.25-0.5	0.2-0.5	0.5-0.5
Length of interval, sec.	0.1-1.25	0.1-1.5	0.2-1.8

Data for *Presbytis johnii* from Horwich (1976) and Herzog and Hohmann (1984). The data for *Presbytis entellus* are based on calls recorded from the Mundanthurai population and differ in some respects from data published by Vogel (1973) for langurs of north India.

association of a mature common langur (presumably a male) with one of the mixed groups led to the assumption that the brown langurs may be hybrids of *Presbytis johnii* and *P. entellus* (Hohmann and Herzog 1985). To confirm this assumption, based predominantly on morphological traits, more evidence was required. Since analyses of chromosomes or blood samples from brown animals were not feasible, further evidence on the behavioural level was looked for. Gautier and Gautier (1977) and Brockelmann (1978) found that species-specific vocal patterns of the parent species (*Hylobathes lar* and *H. pileatus* and *Cercopithecus ascanius* and *C. pogonias* respectively) were changed in the hybrid offspring.

Adult males of *Presbytis johnii* and *P. entellus* utter loud calls, commonly known as whoops or whoopings (Jay 1965, Poirier 1970). Although the units of these vocal patterns have a similar sound structure, the calls of both species are easy to distinguish by audition.

In the study reported here, sonagrams of loud calls of a male langur with the described coat colour aberration have been analysed and compared with loud calls of *Presbytis johnii* and *P. entellus*. More recent observations on interspecific relationship and interspecific association are described and possible mechanisms of limitation of hybridisation are discussed.

RESULTS

Although loud calls were emitted several times a day, only six complete whoop series of the brown langur male could be recorded and analysed. According to the auditive impression, the recorded calls did not differ from other whoops heard from the same male. Sonagrams of initial phrases of *Presbytis johnii* and a brown coloured male and a whoop series of a male *Presbytis entellus* are shown in Plate1. For physical parameters of the loud calls see Table 1.

Sound structure: All units of the first phrase (initial phrase) are tonal, with the energy distributed on narrow bands at low frequencies. Most units are two-phasic, starting with a relatively noisy inhalation phase (i-phase) with a lower amplitude followed by a tonal exhalation phase (e-phase) with a high amplitude. In the first and last units of a phrase, the i- phase may be absent. The whoop phrases of the brown male have an irregular time pattern. In all recorded units, the basic frequency remains rather stable and the range of modulation is small. Usually, the initial phrase is followed by another phrase, compiled only of noisy harsh barks (Plate 1).

Context: Whoops of the brown male were uttered in different situations. Like males of *Presbytis johnii* and *P. entellus*, the brown male regularly uttered the first series early in the morning (between 0530 and 0630 hrs) in unison with the first whooping bout of the Nilgiri langurs. These first series were comparatively longer (7 to 9 units) than series uttered later in the day. At the end of the first phrase of these morning calls, the male froze in a specific stop position (Horwich 1976). In all of the morning whoops heard, the initial phrase was followed by one or more harsh bark phrases. Besides these regular morning calls, dif-

ferent situations of unspecific disturbance could evoke whoop series at any time of the day. In those cases, the initial phrases were shorter and the described stop position or other specific postures were absent.

Discussion

Loud calls of the type described above are notable for their discrete and stereotyped structure (Marler 1972). Despite some similarities of the whoop-units of *Presbytis entellus* with single units of an initial phrase of *P. johnii*, the calls of both species are characterized by distinctive features. The structure and composition of the loud call of the brown male shows partly an intermediate design compiled of elements of both *Presbytis johnii* and *P. entellus*.

The timing of the longer phrases of the brown male does not show the elaborate organization typical of the initial phrase of *Presbytis johnii*. The number of units per phrase is lower, but the intervals are longer than in whoops of Nilgiri langurs. Also, the shift of the basic frequency in the course of the phrase from lower to higher ranges and back which is typical for *P. johnii*, was never found in a phrase of the brown male. On the other hand, the stop position which marks the end of the initial phrase of the loud call of Nilgiri langurs was absent in common langurs but regularly occurred at the end of the brown male's morning whoop.

An even more important finding was the utterance of a second phrase (compiled of harsh barks) by the brown male because this is a feature of loud call bouts of *Presbytis johnii* but does not occur in loud calls of *P. entellus*. However, a similar bark is uttered by *entellus* males in situations of unspecific disturbances or during agonistic interactions between males (Hohmann in prep.). it is interesting to note that in loud calls of a sub-adult *johnii* male who started to utter this call (characteristic of adult leader males), the timing of the initially short phrases was similar to that of the brown male. During the following three months, this male prolonged the phrases and developed the timing considerably (Hohmann in prep.). In the brown male, however, the length as well as timing of the phrases remained unaltered for almost one year (until the end of the study).

In addition to the morphological features and the interspecific association, the evaluation of the intermediate pattern of the loud calls of a brown langur male substantiates the assumption that the brown langurs are hybrids of *Presbytis johnii* and *P. entellus*.

During the recent field work in the area of Anamalai, no further clues for interspecific association were available. The brown individuals were confined to four groups and included juvenile, sub-adult and adult animals of both sexes.

Whereas various aspects of the interspecific relationship of *Presbytis entellus* and *P. senex* have been studied in detail (Hladik 1977, 1979), the relationship of Nilgiri langurs with common langurs in south India is still unknown. Along the eastern slopes of the southern part of the Western Ghats, the ranges of both species frequently overlap and interspecific interactions have been observed several times.

Of special interest is the situation in Mundanthurai (Agastyamalais), a place close to the area where brown langurs have been reported by Oates (1982). Here, a single Nilgiri langur male reportedly joined a group of common langurs for a longer period and mated with a female of this species (Chellam 1985). During the time of the study reported here (June 1986 to November 1987), the same group of common langurs was joined by an all-male group of five Nilgiri langurs. The interspecific relationship was characterized by dominance of the Nilgiri langurs who also initiated all contact attempts. Moreover, two other Nilgiri langur males were members of two heterosexual groups of the other species. Here, the interspecific relationship can be described as peaceful coexistence.

The best example of the close association of these Nilgiri langur males with their host groups

[3] The data of Tanaka differ strikingly from the results of Poirier (1969) but are in accordance with the data for Nilgiri langurs of Mundanthurai (Hohmann in prep.).

was the regular performance of the whooping display early in the morning. Regularly, the Nilgiri langur males started with an elaborate whooping display, followed by the irregular whoop series of the common langur males. It is important to note that single Nilgiri langur males or males of all-male groups usually do not perform this display (Hohmann in prep.). Surprisingly, despite the long-standing association of these species, there is no recent evidence for hybrids in this population of common langurs.

Several mechanisms, preventing a successful copulation of a male Nilgiri langur with a female of the other species, are possible. One could be a lower *a priori* chance for a single *johnii* male. As known from various field studies, Nilgiri langurs live in groups with normally one adult male (mean sex ratio 1:8, Tanaka 1965)[3]. In contrast, groups of common langurs in the population mentioned above contained up to six matured males and frequently additional all-male groups were attached. Using the data published by Oppenheimer (1977), the mean sex ratio for common langurs is 1:4.2 (males of all-male groups not considered). Neglecting all losses and detriments of the intruder, the *a priori* chance of mating by an *entellus* male would be twice as high as that by a *johnii* male.

Moreover, behavioural mechanisms, like a higher copulation competition among females and a more effficient copulation timing in males of common langurs, may further reduce the chance of a Nilgiri langur male. On the other hand, the strategy of *entellus* females of choosing as consort not the group leader but a low-ranking male, or males from outside the group (Vogel 1975) may increase the chances for a *johnii* male.

Recently, some *entellus* males of the Mundanthurai population left their groups and settled higher in the mountains. Here, at the fringe of the rainforest, population density of Nilgiri langurs is high and the situation is now similar to that of Anamalai. It remains to be seen whether the common langur males can take advantage of the situation and associate with the other species.

If that happens, another population with hybrid langurs may be expected. Further field studies are necessary to understand the mechanisms and strategies which regulate the relationship between these two species. Nevertheless, the design of the interspecific relationship between them as described above may not be a peculiarity of this special population only, but may reflect a more general trend in the relation between the two species.

As outlined by Waser (1987), competition between primate species can severely affect their distribution patterns. Hitherto, the restriction of Nilgiri langurs to forests at higher elevations only has been related mainly to factors like habitat destruction and poaching. The absence of the species in lower areas is certainly due to the lack of suitable habitat. However, in a survey of different areas of the Western Ghats it was found that the population of Nilgiri langurs in mixed or dry deciduous forests at lower altitudes (500 m or below) were similar to those in higher forests, provided the other species was absent (Hohmann and Wesley in prep.). On the other hand, some montane rainforest areas in the Western Ghats where Nilgiri langurs are absent are occupied by common langurs (Daniels, pers. comm; pers. obs.).

It seems that *Presbytis johnii* is not specialized to the small niche of rainforests but more flexible, and similar in its ecological adaptation to *P. senex*. Thus, it is assumed that the distribution pattern of Nilgiri langurs is not exclusively determined by factors like habitat destruction or poaching, but is also affected by interspecies competition with *Presbytis entellus*.

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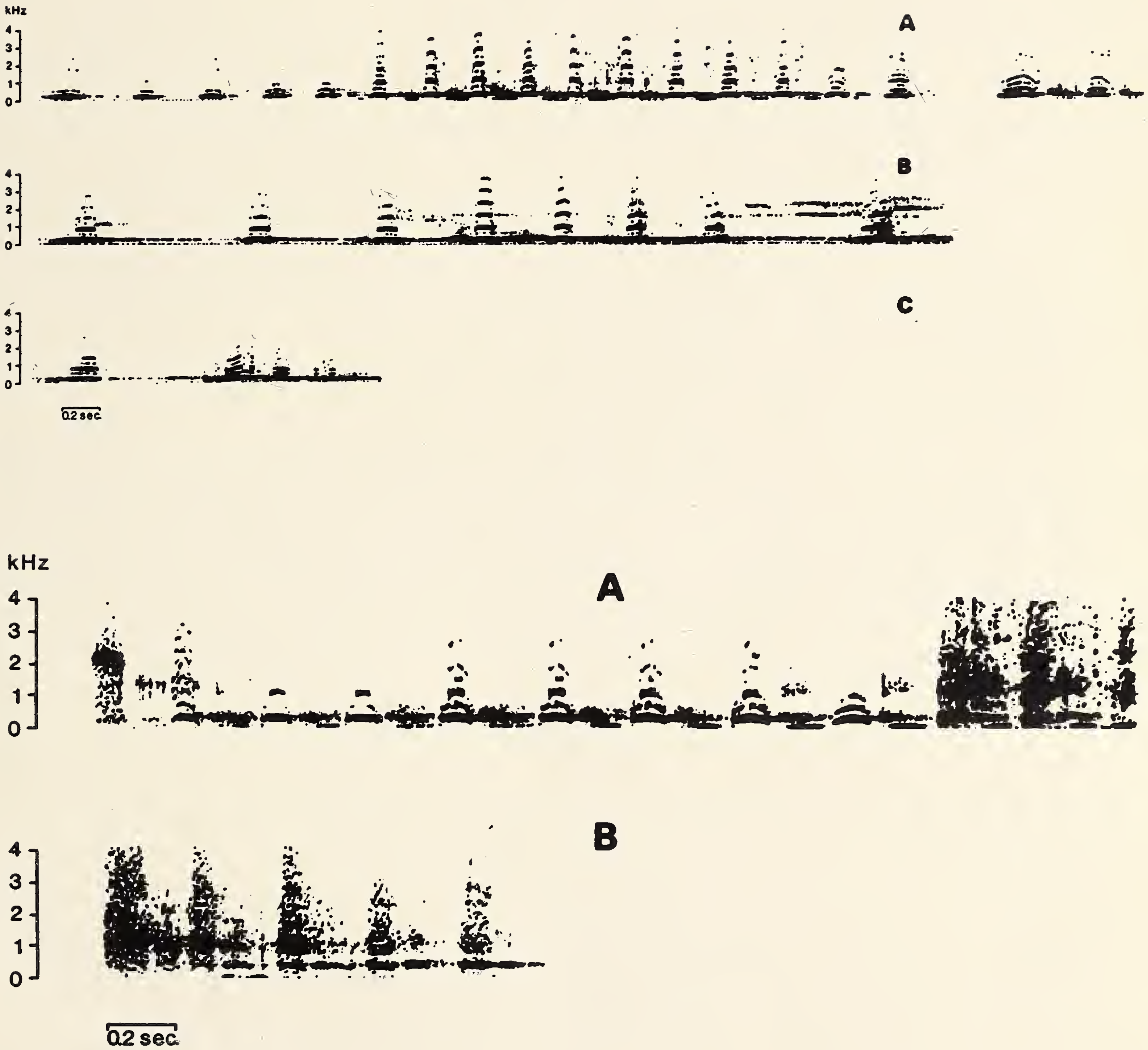

Above: Initial phrases of *Presbytis johnii* (A) and a brown coloured male (B), and a whoop series of a male *P. entellus* (C). *Below:* Loud call phrases following the initial phrase (shown above) of *P. johnii* (A) and the brown male (B). In *P. johnii,* the phrase is compiled of noisy harsh barks and tonal units. The brown male utters only harsh barks.

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References

Anonymous (1953): A local variety of the Nilgiri langoor. *J. Bombay nat. Hist. Soc. 51:* 720.

Brockelmann, W.Y. (1978): Preliminary report on relations between the gibbons *Hylobates lar* and *H. pileatus* in Thailand. pp. 315-318 *In:* Recent advances in Primatology, Vol. 3. D. Chivers, Joysey (Eds.). Academic Press, London.

Chellam, R. (1985): Langurs of Mundanthurai. *Blackbuck 1:* 20-26.

Gautier, J.P. & Gautier, A. (1977): Communication in Old World monkeys. pp. 890-964. *In:* How animals communicate. T.A. Sebeok (ed.). Indiana University Press, Bloomington.

Herzog, M.O. & Hohmann, G.M. (1984): Male loud calls in *Macaca silenus* and *Presbytis johnii* - a comparison. *Folia primatol. 43:* 189-197.

Hladik, C.M. (1977): A comparative study of the feeding strategies of two sympatric species of leaf monkeys; *Presbytis senex* and *presbytis entellus.* pp. 481-501. *In:* Primate ecology: studies of feeding and ranging behaviour in lemurs, monkeys and apes. T.H. Clutton-Brock (ed.). Academic Press, London

Hladik, C.M. (1979): Ecology, diet, and social patterning in Old and New World primates. pp. 513-542 *In:* Primate ecology: problem-oriented field studies. R.W. Sussman (ed.). John Wiley and Sons, New York.

Hohmann, G. & Herzog, M. (1985): Die braunen Languren Sudindiens. *Zeitschr. Kolner Zoo 28:* 37-41.

Horwich, R. (1976): The whooping display in Nilgiri langurs: an example of daily fluctuations superimposed on a general trend. *Primates 17:* 419-431.

Jay, P. (1965): The common langur of north India. pp. 197-249 *In:* Primate behaviour: field studies of monkeys and apes. I. Devore (ed.). Holt, Rinehart and Winston, New York.

Kurup, G.U. (1975): Status of the Nilgiri langur, *Presbytis johnii* in the Anaimalai, Cardamom and Nilgiri Hills of the Western Ghats, India. *J. Bombay nat. Hist. Soc. 72:* 175- 197.

Napier, J.R. & Napier, P.H. (1967): A handbook of living primates. Academic Press, London.

Oates, J.F. (1979): Comments on the geographical distribution and status of the south Indian black leaf-monkey *Presbytis johnii. Mammalia 43:* 485-493.

Oates, J.F. (1982): Coat color aberrations in *Presbytis johnii:* a founder effect? *Primates 23:* 307-311.

Oppenheimer, J.R. (1977): *Presbytis entellus,* the Hanuman langur. pp. 469-512 *In:* Primate conservation. Prince Rainier III of Monaco, H. Bourne (eds.) Academic Press, New York.

Porier, F.E. (1969): The Nilgiri langur troop: its composition, structure, function and change. *Folia primatol. 10:* 20-47.

Poirier, F.E. (1970): The Nilgiri langur *Presbytis johnii* of South India. pp. 251-383 *In:* Primate behaviour: developments in field and laboratory research, Vol. 1. L.A. Rosenblum (ed.) Academic Press, New York.

Tanaka, J. (1965): Social structure of Nilgiri langurs. *Primates 6:* 107-122.

Vogel, C. (1973): Acoustical communication among free-ranging common Indian langurs (*Presbytis entellus*) in two different habitats of North India. *Am. J. phys. Anthrop. 38:* 469-480.

Vogel, C. (1975): Okologie, Lebensweise und Sozialverhalten der grauen Languren in verschiedenen Biotopen Indiens. *Fortschritte der Verhaltensforschung 17.* Paul Parey, Berlin.

Waser, P.M. (1987): Interactions among primate species. pp. 210-226 *In:* Primate societies. B.B. Smuts, D.L. Cheney, R.M. Seyfarth, R.W. Wrangham, T.T. Struhsaker (eds.) University of Chicago Press, Chicago.

ISLAND BIOGEOGRAPHY AND THE BIRDS OF THE LAKSHADWEEP ARCHIPELAGO, INDIAN OCEAN[1]

R.J. Ranjit Daniels[2]

(*With three text-figures*)

The results of a brief survey of the birds on five islands of the Lakshadweep archipelago, Indian ocean, have been discussed. The recent data has been compared with the data published in the past century and earlier this century. These islands are impoverished with regard to their terrestrial habitats and as a result, the number of resident landbirds and inland waterbirds. On the islands surveyed, both in the past and now, 14 species of landbirds and inland waterbirds appear to be residents though direct evidence of breeding is available for only a few of these. The larger islands have a larger number of these resident birds than the smaller. The species-area model predicts between 9 and 20 species of resident landbirds and inland waterbirds on the entire archipelago. The effect of distance from mainland on the avifauna of the island is obscured by the area. Habitat availability seems to have determined the success of colonisation of the islands by birds. A few species of birds have been introduced. However, not all are naturalised.

Introduction

Oceanic islands are known for their overall impoverishment of biota as compared with similar areas on continents. They are essentially maritime and lack habitat complexity. The relative impoverishment of biota is a result of their origin, size, distance from mainland and also recently, human interference. Due to problems of dispersal, many groups of animals can never reach oceanic islands unaided.

Birds, however, have reached many oceanic islands and colonised them. Oceanic islands have thus a few species of resident landbirds and inland waterbirds, sometimes, none at all. These birds are from the nearest mainland source generally. Families and genera are represented by a few species. The populations are small, especially on small islands. As a result, many island species are extinction-prone.

The other characteristics of island birds is that of being relicts and often endemics. Most oceanic islands have introduced species of landbirds and inland waterbirds today. Some of these are quite naturalised. In what follows, the birds of the Lakshadweep archipelago have been characterised by their status, and possible origin. The extent to which the present avifauna on these islands has been influenced by size of islands, distance from mainland, habitat availability and human beings has been analysed.

Methods and Study Area

Data: A fortnight's cruise aboard the R.V. Gaveshani to the Lakshadweep archipelago, Indian ocean, during April 1988 has provided some data on the birds of the islands. Five inhabited islands (Table 1) were visited and all the birds were recorded going around and across the islands. Each island was thus surveyed for its birds on two consecutive days. Despite the data being small, the islands have been compared between themselves considering their present avifauna and with the published lists of birds from the islands in the past (Hume 1876, Betts 1938, Watson *et al.* 1963, Mathew and Ambedkar 1964).

The islands: The Lakshadweep archipelago is one of the Indian ocean groups of islands lying between 8° to12°3′ N and 71° to 74° E. The shortest distance between the islands and the mainland is at least 250 km. Minicoy, the southernmost island in the archipelago, is separated from the rest by a distance of nearly 200 km. The archipelago, politically under India, has 36 islands — atolls, reefs and emergent banks, which together cover 32 sq. km. Nine of the larger islands and recently one little island, Bangaram (Fig. 1), are inhabited. The population density

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Table 1
AREAS, DISTANCES FROM MAINLAND INDIA, HUMAN POPULATION AND NUMBER OF SPECIES OF RESIDENT LANDBIRDS AND INLAND WATERBIRDS OF FIVE ISLANDS

Island	Area (sq. km)	Distance from mainland (km)*	Human population per sq. km	Number of species of resident land birds and inland waterbirds
Minicoy	4.37	444	1513	6
Kalpeni	2.28	263	1540	4
Kavaratti	3.63	346	1819	5
Kiltan	1.63	252	1484	4
Chetlat	1.03	269	1484	3

*After anonymous (1985).

ranges from 1200-2000 per sq. km. Most islanders are Muslims.

The Lakshadweep archipelago is oceanic, low and flat topographically and coraline. It receives about 150 cm of rainfall annually. Relict patches of low littoral vegetation with *Scaveola* sp. can be scantily seen in the remote parts of the islands (Saldanha 1989). Of the five inhabited islands visited, only Minicoy had a small tidal swamp with shrubs bordering it at its north-western end. The vegetation on the islands was otherwise dominated by coconut palms dotted with trees and shrubs like *Erythrina indica, Azadirachta indica, Casuarina* sp., *Callophyllum inophyllum, Ficus* sp., *Terminalia catappa, Tamarindus indicus, Moringa pterygosperma,*

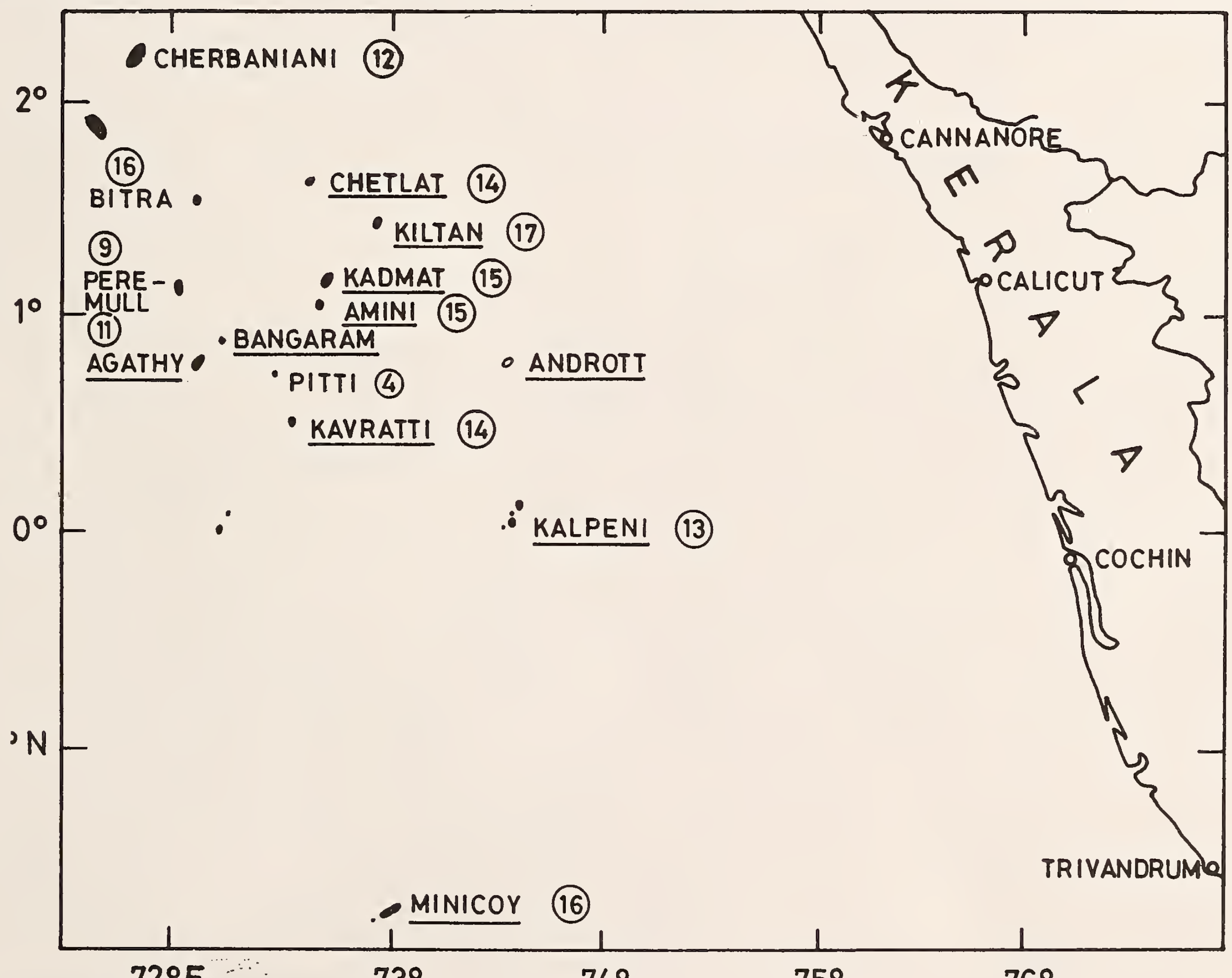

Fig. 1. The Lakshadweep archipelago.

Thespesia sp., *Artocarpus utilis, Carica papaya, Cerbera* sp., *Ricinus communis, Pandanus* sp., and other ornamentals mostly around the settlements. Introduced livestock such as cattle, goats and chicken roam the inhabited islands. Rats were the common rodents. Garden lizards and geckos were the only terrestrial reptiles on the islands. There are dogs, swine and cats on the inhabited islands.

Results and Discussion

Avifauna: Between 1876 and 1988, the total number of bird species authentically reported from the islands and the adjacent waters is 67. However, only 12 out of the 36 islands have been visited by the different surveyors. Four to 17 species of birds are known from each of these 12 islands (Fig. 1). The surveys were brief, none exceeding a fortnight, and all restricted to the months of February (Hume 1876, Betts 1938), April (this study) and October (Mathew and Ambedkar 1964). Also, since there is not even one set of year round data from the islands, what we have is obviously incomplete.

Landbirds in the families Accipitridae, Falconidae, Pandionidae, Columbidae, Psittacidae, Cuculidae, Strigidae, Alcididae and a few passerines along with inland waterbirds like Ardeidids, Anatids, a Recurvirostrid and a Rallid make up 50% of the 12 islands' hitherto known avifauna. The other 50% consists of migratory waders and the typically oceanic birds like terns, skuas, petrels, boobies, etc. (see Appendix). Of the 34 species of landbirds and inland waterbirds, only 14 are possibly resident in one or more of the islands. The definite evidence of these birds breeding on the islands is however what is known of the blue rock pigeon *Columba livia*, the koel *Eudynamys scolopacea*, the house crow *Corvus splendens* and the white-eye *Zosterops palpebrosa*.

The most significant feature of the Lakshadweep archipelago is the breeding colony of terns in Pitti island and that in Cherbaniani island. Both are uninhabited. Thousands of sooty terns *Sterna fuscata*, large crested terns *Sterna bergii* and noddy terns *Anous stolidus* are known to breed on these islands (Hume 1876, Mathew and Ambedkar 1964). The Lakshadweep archipelago, besides the three species of terns mentioned above, may have birds like the wedgetailed shearwater *Puffinus lherminieri* and boobies *Sula* spp., breeding off and on (Feare 1984).

Immigration/colonisation and species source: The Lakshadweep archipelago in all probability has three sources from which it has derived its resident landbirds and inland waterbirds, viz. mainland India, Sri Lanka and Maldives. Kerala, the nearest mainland source, has about 300, Sri Lanka about 250 and Maldives, an archipelago of about 2500 islands, seven species and subspecies of resident landbirds and inland waterbirds. The Maldives itself has derived its resident landbirds and inland waterbirds from India and Sri Lanka (Phillips 1963). Minicoy island is closer to the Maldives than it is to mainland India or Sri Lanka. Two out of its six species, viz. the whitebreasted waterhen *Amaurornis phoenicurus* and the little egret *Egretta garzetta* are shared with the Maldivian archipelago and not with any island in the Lakshadweep archipelago. The little egret, however, has been doubtfully recorded as occurring elsewhere on the Lakshadweep archipelago (Mathew and Ambedkar 1964). The white-eye which is spread over most of the other inhabited islands, is absent in Minicoy (Fig. 2). This species has not reached the Maldives either.

The Lakshadweep archipelago has just two species of resident landbirds and inland waterbirds if the MacArthur and Wilson (1967) definition of immigrants is strictly adhered to. The koel and the white-eye are probably the only successful colonists on the islands (Appendix). The small blue kingfisher *Alcedo athis*, the whitebreasted waterhen, the blackwinged stilt *Himantopus himantopus*, the little green heron *Butorides striatus*, the reef heron *Egretta gularis* and the cattle egret *Bubulcus ibis* are single records from single islands. The grey heron *Ardeola cinerea* and pond heron *Ardeola grayii* and the little egret, though more numerous, have not been reported as breeding on the islands. The only evidence we

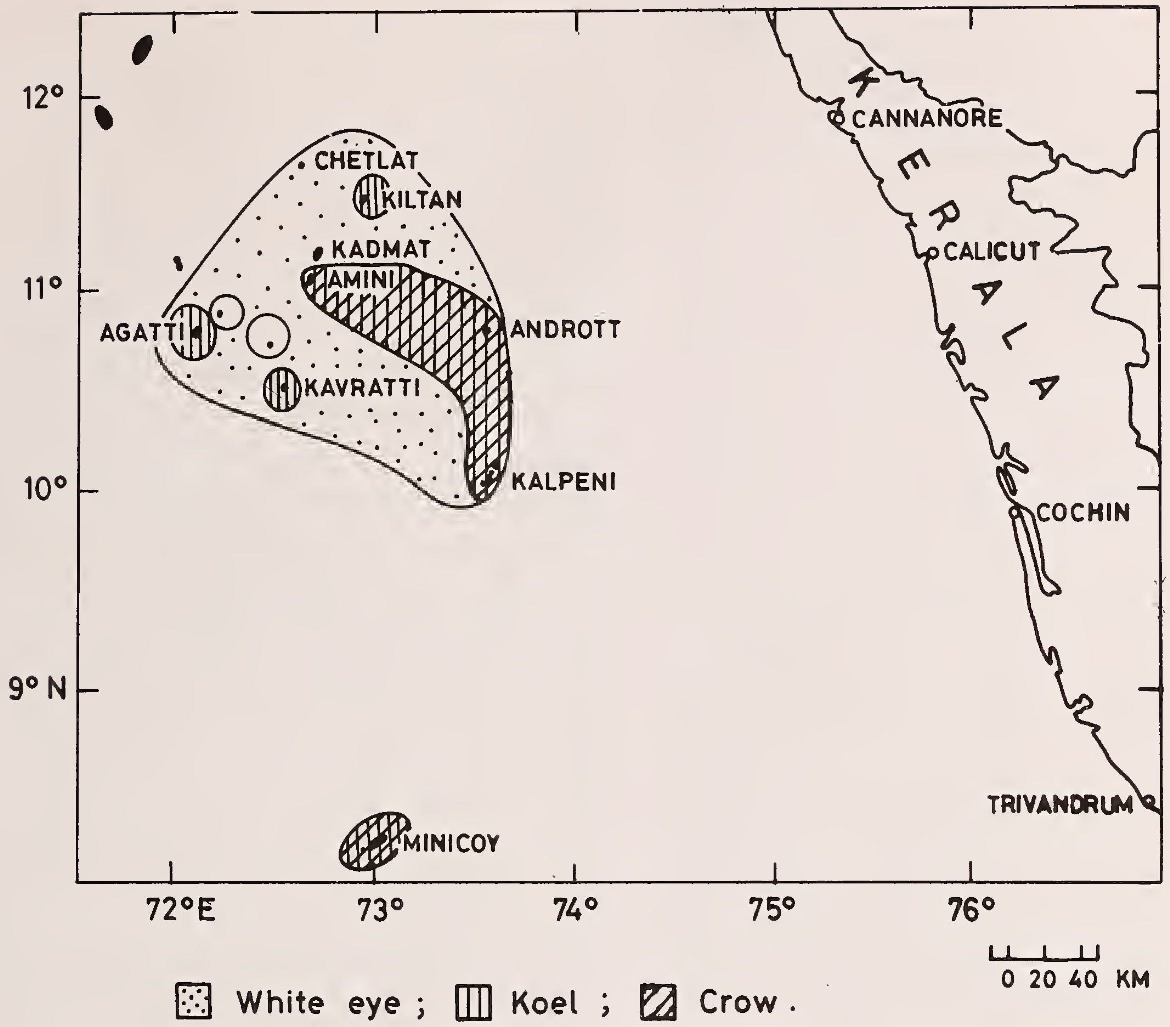

Fig. 2. Occurrence of the white-eye, koel and house crow in different islands of Lakshadweep.

have is the pond heron sighted in breeding plumes in April 1988. This species probably breeds on the islands. The Indian race *grayii* of the pond heron and the little egret have been reported as migrants on the Maldives (Phillips 1963).

Extinction: Whether any species of resident landbird or inland waterbird has gone extinct from the Lakshadweep archipelago or specifically from any of the islands is not evident from the data available. If the archipelago served as 'stepping stones' for these birds to have reached the Maldives, at least a few species would have appeared and disappeared from the islands in the process. These species need not be considered as extinct from the islands in the strict sense (MacArthur and Wilson 1967). Ten islands have been surveyed at least twice in the past 110 years. Three islands, viz. Kiltan, Chetlat and Kavaratti have been surveyed thrice. Only two species, viz. the small blue kingfisher reported from Kavaratti (Mathew and Ambedkar 1964) and the little green heron reported from Kadmat (Hume 1876) have not been subsequently seen. Both species are known from single records. The kingfisher was not recorded earlier either (Hume 1876). This suggests that these birds were possibly casuals or strays.

If the little green heron, pond heron, white-breasted waterhen and the house crow have reached the Maldives stepping over the Lakshadweep archipelago and in course of time, except the waterhen, evolved into endemic races in the Maldives, it implies that these species have had an 'in-and-out' status on the Lakshadweep archipelago for a fairly long time. That all records of these species of inland waterbirds on the Lakshadweep archipelago between 1876 and 1988 are of birds belonging to the nominate Indian races suggests that individuals or small populations keep arriving on these islands from the mainland.

The race *phoenicurus* of the waterhen found in south India and Sri Lanka, however, also com-

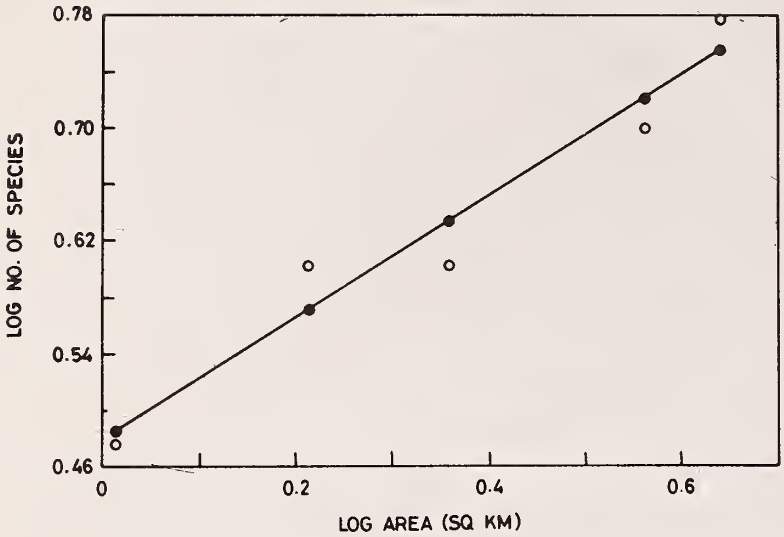

Fig. 3. Relationship between area and number of species of resident landbirds and inland waterbirds on five islands.

monly breeds on many islands in the Maldivian archipelago (Phillips 1963). Considering the weak flight capacity of this species, it seems likely that the bird sighted on Minicoy island in 1988 belonged to a small population resident on the island or already dwindling. The only earlier record of this species from the islands of Lakshadweep is that of Ellis quoted in Betts (1938). As neither the year nor the island where it was sighted has been mentioned, whether the species was found on other islands also and disappeared cannot be said, despite it being a possibility.

Species-area relationship: If the strict definition of an immigrant is for the moment ignored, it appears by the data from the five islands visited in 1988, that the numbers of species of resident landbirds and inland waterbirds on the Lakshadweep archipelago are related to the size of the islands (Table 1). The relationship between log area and log number of species of resident landbirds and inland waterbirds on the five islands visited during this study is shown in Fig. 3. The species-area model, viz.

$S = c A^z$ or $\log S = \log c + z \log A$,

where S is the number of species, c the constant, A the area of the island and z the slope,

was used to fit this line. The values of c, z and r are 3.0, 0.43 ± 0.12 and 0.97 respectively. This observed range of z, 0.31-0.55, is comparatively higher than the general range given, 0.15-0.40 (Williamson 1981). On islands, the z values have been observed to be steeper than on continents (Preston 1962). Values as high as 0.7 are known. This is also true of small islands and small samples. If therefore the estimated range of z given above for the islands is taken as realistic and the five islands are treated together as a single island of 32 sq. km, there would be 13 species (range 9-20) of resident landbirds and inland waterbirds in the Lakshadweep archipelago. The total number of resident landbirds and inland waterbirds, including those doubtfully resident and introduced, known from the archipelago is 15 (Appendix). Only 10 of these were seen in the recent survey. However, since only five islands have been surveyed, it is not unreasonable to presume that there may be a few more resident landbirds and inland waterbirds on the archipelago. Also, since the surveys were brief, even on the islands visited, a few species could have been overlooked. The individual islands of Lakshadweep, for their size, are certainly impoverished in terms of the number of species of resident landbirds and inland waterbirds. For example, a locality in the mainland of comparable size, viz. the campus of the Indian Institute of Science, Bangalore (1.7 sq. km), has at least 52 species of resident landbirds and inland waterbirds despite being in the heart of a highly urbanised city. There are many available habitats, both natural and man-made. The influence of distance on the birds of these five islands is not clear (Table 1). The farther islands have more resident species than the nearer ones. This possibly is a result of the farther islands also being larger in area.

Influence of habitat: The koel must have colonised the islands only after the arrival of man. The new niches created by man favoured the establishment of the house crow which in turn made the koel a successful colonist on the islands. Koels seem to be good dispersers. Their tendency to wander is reflected by their occasional presence on islands where there are no crows, the host birds for this parasitic cuckoo (Fig. 2). Similarly the presence of the white-eye on all the inhabited islands (except Minicoy island) suggests its

colonisation following man. Its occurrence on Androth island is however not confirmed (Figs. 1, 2). On the mainland, this species occupies a range of habitats from montane evergreen forests to highly urbanised city gardens. The new niche created around human settlements in the form of coconut gardens and mixed orchards of other domestic trees seem to have ensured success of this species on the islands. Species of *Zosterops* are very dispersive and have proved successful in establishing populations in many parts of the world including offshore islands, both aided and unaided by man (Lever 1987).

Lack (1976) suggests that the number of species on an island reflects the climate, habitats, size, etc. The small numbers of resident species of landbirds on islands are due to ecological limitations. The failure of these birds to establish populations comes from a failure to find the right conditions. Small islands are too exposed and less diverse in habitats and hence landbirds often fail to colonise them. Failure of any species to establish itself in an island due to lack of appropriate habitat can be taken as a valid point.

Compared to Lakshadweep, the Maldives have higher rainfall (200-250 cm) and as a result, more luxuriant vegetation, shallow brackish and freshwater pools and marshy areas with extensive reed beds, rank grass and matted *Pandanus* brakes (Phillips 1963). Except probably in Minicoy, generally such habitats are absent in the Lakshadweep archipelago. The only individual of the whitebreasted waterhen on the islands visited in 1988 was observed in the Minicoy swamp. This partly explains the species' absence from the rest of the surveyed islands.

Similarly, the only record of the little green heron is from the Kadmat island, which had, at least at that time, a dense growth of low natural vegetation (Hume 1876). The waterhen, as mentioned earlier, is a well established colonist on the Maldives and the little green heron, besides existing as two resident endemic races on the Maldives, is found as more than 30 different races over the entire tropical and subtropical belts including most of the islands (Howard and Moore 1980).

A classic example of a species extending its geographic range within a short period with the availability of suitable habitat is the cattle egret. Between 1937 and 1954 the species has extended its range from the warmer Eurasia and Africa to South, Central and North America, Bermuda, Australia, New Zealand and New Guinea (Lever 1987). The isolated records of single birds on the Lakshadweep archipelago suggest the failure of this species to colonise the islands. Though there are cattle on the islands, there are no pastures or open ground where they can graze.

Lack of appropriate habitat apparently prevents the colonisation of an otherwise highly dispersive species. Diamond (1971), among other factors responsible for making species of birds unsuccessful or extinction-prone on islands, includes three habitat related factors, viz. narrow habitat requirements, marginal suitability of habitats and small size of available habitats.

Introduction and naturalisation: Introduction is the process of any species or race reaching a territory aided by man, directly or indirectly, where it never existed before. Naturalisation on the other hand is the establishment of self regenerating population (unsupported by and independent of man) of an introduced species or form in a free-living state in the wild (Lever 1987). When rats become a menace on the islands of the Lakshadweep archipelago, the brown wood owl *Strix leptogrammica* was introduced in the latter half of the 19th century. However, these were soon eliminated from the islands by the islanders, basically out of prejudice against a night bird (Hume 1876). This species of owl being a forest bird (Ali and Ripley 1983) could not have anyway naturalized on islands dominated by coconuts with a dearth of natural nest-holes.

Similarly, the Indian myna *Acridotheres tristis* introduced on the islands earlier this century (Ali and Ripley 1983) seems to have failed to naturalise on the islands; the species has not been encountered during recent surveys on any of the inhabited islands. This is surprising, since the species is well established in many parts of the

world, including parts of North America, where it was introduced (Lever 1987). The blue rock pigeon is feral on the islands. Colour variants, certifying domestic ancestry, are more common on the islands. Roseringed parakeets *Psittacula krameri* seen on the islands are probably escapees from cages and that too very recent, since they have not been observed in the 1960s (Mathew and Ambedkar 1964). The species is certainly not naturalised.

If the house crow is an introduced species on the island, it is the only species that has really naturalised on the islands. Where present, it is practically abundant. It is absent on uninhabited islands. Also its pattern of distribution on the islands (Fig. 2) suggests that the bird does not disperse on its own. It is present on Minicoy island. The next population is on Kalpeni, 200 km north of Minicoy. Kalpeni to Androth and Androth to Amini, the distance would be a little over 60 km. The crow is found in all these. Surprisingly it is absent from Kadmat, an island about 10 km from Amini and also visible from it. Betts (1938) records how the crow was once introduced on Kadmat but was soon eliminated by the islanders.

Lack (1976) attributes the failure of the introduced species of birds on the island of Jamaica to unsuitability of habitat and the presence of native competitors. Unsuitability of the habitat could have partly been responsible for the demise of the owl on the islands. Rats, which can destroy the eggs and chicks of hole-nesting birds, probably also played the role of competitors in detering the success of the owl and myna on the islands where they were introduced. Hume (1876) mentions that when cats were introduced on the islands, the rats "took to the tree-tops." The tree-dwelling rats were there on the islands certainly before the owls and the mynas. Man's role in the success or failure of introduced species of birds such as the crow (on at least one island) and the owl on these islands is quite evident.

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References

Ali, S. & Ripley, S.D. (1983): Handbook of the birds of India and Pakistan. Compact Edition. Oxford University Press, New Delhi.

Anonymous (1985): Union territory of Lakshadweep: basic statistics. Secretariat, Kavaratti.

Betts, F.N. (1938): The birds of the Laccadive Islands. *J. Bombay nat. Hist. Soc. 40:* 382-387.

Diamond, J.M. (1971): Comparison of faunal equilibrium turnover rates on a tropical island and a temperate island. *Proc. Nat. Acad. Sci. USA. 68:* 2742-2745.

Feare, C.J. (1984): Seabird status and conservation in the tropical Indian ocean. *In:* Status and conservation of the world's Seabirds. ed. Croxall, J.P., Evans, P.G.H. and Schreiber, R.W. ICBP Tech. Publication no. 2: 457-471.

Howard, R. & Moore, A. (1980): A complete checklist of the birds of the world. Oxford University Press, Oxford.

Hume, A.O. (1876): The Laccadives and the west coast. *Stray Feathers 4:* 413-483.

Lack, D. (1976): Island Biology. Blackwell Scientific Publications, Oxford.

Lever, C. (1987): Naturalized birds of the world. Longman Scientific and Technical, New York.

Mac Arthur, R.H. & Wilson, E.O. (1967): The theory of island biogeography. Princeton University Press, Princeton.

Mathew, D.N. & Ambedkar, V.C. (1964): A bird study trip to the Laccadive Islands. *J. Bombay nat. Hist. Soc. 61:* 185-190.

Phillips, W.W.A. (1963): The birds of the Maldive Islands, Indian Ocean. *J. Bombay nat. Hist. Soc. 60:* 546-584.

Preston, F.W. (1962): The canonical distribution of commonness and rarity. *Ecology 43:* 185-215, 410-432.

Saldanha, C.J. (1989): Andaman, Nicobar and Lakshadweep: An environmental impact assessment. Oxford and IBH Publishing Co., New Delhi.

Watson, G.E., Zusi, R.L. & Stoner, R.E. (1963): Preliminary field guide to the birds of the Indian ocean. Smithsonian Institution, Washington D.C.

Williamson, M. (1981): Island Populations. Oxford University Press, Oxford.

APPENDIX

A LIST OF BIRDS KNOWN FROM THE LAKSHADWEEP ARCHIPELAGO AND THE ADJACENT WATERS

Sl. No.	Name of species	Status
Procellaridae		
1.	Wedge tailed shearwater *Procellaria pacifica*	U*
2.	Persian shearwater *Procellaria lherminieri*	U*
3.	Jouanin's gadfly petrel *Bulweria fallax*	U*
4.	Wilson's storm petrel *Oceanites oceanicus*	U*
5.	Forktailed storm petrel *Oceanodroma leucorhoa*	U*
Phaethontidae		
6.	Short-tailed tropic-bird *Phaethon aethereus*	U*
Sulidae		
7.	Masked booby *Sula dactylatra*	R
8.	Redfooted booby *Sula sula*	R
9.	Brown booby *Sula leucogaster*	R
Ardeidae		
10.	Eastern grey heron *Ardea cinerea*	R?
11.	Little green heron *Butorides striatus*	R?
12.	Indian pond heron *Ardeola grayii*	R?
13.	Cattle egret *Bubulcus ibis*	R?
14.	Little egret *Egretta garzetta*	R?
15.	Indian reef heron *Egretta gularis*	R?
Anatidae		
16.	Common teal *Anas crecca*	M
17.	Garganey *Anas querquedula*	M
18.	White-eyed pochard *Aythya nyroca*	M
Accipitridae		
19.	Blackwinged kite *Elanus caeruleus*	M
20.	Pariah kite *Milvus migrans*	S
21.	White-bellied sea eagle *Haliaeetus leucogaster*	S
22.	Pale harrier *Circus macrourus*	M
23.	Montagu's harrier *Circus pygargus*	M
24.	Marsh harrier *Circus aeruginosus*	M
Pandionidae		
25.	Osprey *Pandion haliaetus*	M
Falconidae		
26.	Peregrine falcon *Falco peregrinus*	M
27.	Kestrel *Falco tinnunculus*	M
Rallidae		
28.	Whitebreasted waterhen *Amaurornis phoenicurus*	R?
Charadriidae		
29.	Grey plover *Pluvialis squatarola*	M
30.	Golden plover *Pluvialis dominica*	M
31.	Large sand plover *Charadrius leschenaultii*	M
32.	Kentish plover *Charadrius alexandrinus*	M
33.	Lesser sand plover *Charadrius mongolus*	M
34.	Whimbrel *Numenius phaeopus*	M
35.	Curlew *Numenius arquata*	M
36.	Greenshank *Tringa nebularia*	M
37.	Common sandpiper *Tringa hypoleucos*	M
38.	Turnstone *Arenaria interpres*	M

Sl. No.	Name of species	Status
39.	Eastern knot *Calidris tenuirostris*	M
40.	Sanderling *Calidris albus*	M
41.	Little stint *Calidris minuta*	M
Recurvirostridae		
42.	Blackwinged stilt *Himantopus himantopus*	R?
Dromadidae		
43..	Crab plover *Dromas ardeola*	U
Stercorariidae		
44.	South polar skua *Catharacta maccormicki*	M*
45.	Pomatorhine skua *Stercorarius pomarinus*	M*
46.	Parasitic skua *Stercorarius parasiticus*	M*
Laridae		
47.	Whitecheeked tern *Sterna repressa*	M
48.	Brownwinged tern *Sterna anaethetus*	R
49.	Sooty tern *Sterna fuscata*	R
50.	Little tern *Sterna albifrons*	U
51.	Large crested tern *Sterna bergii*	R
52.	Lesser crested tern *Sterna bengalensis*	R
53.	Noddy tern *Anous stolidus*	R
Columbidae		
54.	Blue rock pigeon *Columba livia*	IR
55.	Rufous turtle dove *Streptopelia orientalis*	S
Psittacidae		
56.	Roseringed parakeet *Psittacula krameri*	IR?
Cuculidae		
57.	Koel *Eudynamys scolopacea*	R
Strigidae		
58.	Brown wood owl *Strix leptogrammica*	IE
Alcididae		
59.	Small blue kingfisher *Alcedo atthis*	R?
Hirundinidae		
60.	Eastern swallow *Hirundo rustica*	M
61.	House martin *Delichon urbica*	M
Lanidae		
62.	Brown shrike *Lanius cristatus*	M
Corvidae		
63.	House crow *Corvus splendens*	IR
Sturnidae		
64.	Indian myna *Acridotheres tristis*	IE
Motacillidae		
65.	Pipit *Anthus* sp.	U
66.	Yellow wagtail *Motacilla flava*	M
Zosteropidae		
67.	White-eye *Zosterops palpebrosa*	R

R:residents; M : migrant; U : uncertain; S : stragglers; I : introduced; E: extinct. Asterix marks those seen only on the ocean. Birds with *italic* serial numbers are those seen by the author in 1988.

REVISION OF THE GENUS *COCCUS* LINN. IN INDIA (INSECTA : HOMOPTERA : COCCIDAE)[1]

RAJENDRA KUMAR AVASTHI[2] AND S. ADAM SHAFEE[3]

(*With nine text-figures*)

An account of 17 Indian species of the genus *Coccus* Linn. is given. Eight species are redescribed and illustrated in detail. A key to Indian species of the genus *Coccus* is also given.

Genus *Coccus* Linn.

Type-species: *Coccus hesperidum* Linn., 1758, subsequent designation by Danzig and Kerzhner, 1981.

Coccus, the oldest genus in the Coccoidea, was proposed by Linn. in 1758 with several species of which *Coccus hesperidum* Linn. was generally accepted as its type. Many nomenclatural and taxonomic problems exist within this genus since its type *Coccus hesperidum* Linn. has never been designated properly (Gill *et al.* 1977). However, most of the authors followed Fernald (1903) in recognising *C. hesperidum* Linn. as its type-species. This also serves as the type for the genus *Lecanium* Burmeister. Williams and Kosztarab (1972) were of the opinion that since *C. hesperidum* is universally accepted as the type of *Coccus*, the genus *Lecanium* Burmeister should have a new type designation.

This problem of duplicity of type has been recently resolved by the International Commission on Zoological Nomenclature by rejecting and invalidating *Lecanium* Burmeister, 1835 (a junior objective synonym of *Coccus* Linn., 1758) and making official the genus *Coccus* Linn. with type-species *Coccus hesperidum* Linn. (Danzig and Kerzhner 1981).

No comprehensive systematic study of the Indian species of *Coccus* is available. The species listed by various authors from the Indian region contain only locality records, host plants records and occasionally biological information and field identification characters which are insufficient for the identity of a species. However, some of these species were fully redescribed by recent coccidologists whereas descriptions of others are still inadequate.

At present the genus is known to contain 17 species from India of which eight are redescribed and illustrated in detail. For the others, which are not fully treated here, the references for their redescription, illustrations and taxonomic notes if any, are given. A key for the separation of Indian species of *Coccus* and the distribution of the species in Indian regions are also given. All measurements are in millimetres. If there is any variation in the measurements, minimum and maximum limits found in the specimens are given as well. The material examined for study were from British Museum (Natural History), London (BMNH) and National Museum of Natural History, Washington D.C. (NMNH). Other material collected by us for study is deposited in Zoological Museum, Aligarh Muslim University, Aligarh (ZMAMU).

KEY TO INDIAN SPECIES OF *Coccus* LINN., BASED ON ADULT FEMALES

1. Tubular ducts absent on venter 2
   Tubular ducts present on venter 4
2. Legs well developed with tibia and tarsus distinctly separated; antennae 7-8-segmented; body oval, elongate oval, not pointed at extremities 3
 – Legs greatly reduced, with tibia and tarsus fused together; antennae 3-segmented, sometimes with membranous division indicating 5 segments; body slender, pointed at extremities (Zimmerman 1948: Fig. 155; Gill *et al.* 1977 : Fig. 3) .... *C. acutissimus* (Green)
3. Dorsal setae curved and apically pointed; paraopercular pores present; a few marginal setae bifurcated or fimbriate; antennae 8-segmented (Ben-Dov 1977: Fig. 1; Gill *et al.* 1977 : Fig 6) ...... *C. longulus* (Douglas)

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KEY TO INDIAN SPECIES OF *Coccus* LINN. (CONTD.)

– Dorsal setae cylindrical and straight; paraopercular pores absent; marginal setae simple; antennae 7-segmented, sometimes with membranous division on 4th segment indicating 8 segments (Fig. 8 ... *C. ophiorrhizae* (Green)

4. Anal plates together oval with cephalolateral and caudolateral margins fused together to form a continuous curve 5

Anal plates together roughly quadrate with cephalolateral and caudolateral margins forming a distinct lateral angle 7

5. Stigmatic clefts each with 3 spines 6

– Stigmatic clefts each with about 20 or more spines (Fig. 1; De Lotto 1959: Fig. 1)... *C. adersi* (Newstead)

6. Marginal setae bifid and fimbriate (Fig. 2; De Lotto 1957: Fig. 2) .... *C. bicruciatus* (Green)

– Marginal setae simple (Rao and Kumar 1952 : Fig. 14) .... *C. watti* (Green)

7. Anal plates each with 3-5 small setae dorsally 8

– Anal plates each with about 15 small setae dorsally (Avasthi and Shafee 1983: Fig. 2) .... *C. kosztarabi* Avasthi and Shafee

8. Dorsal setae cylindrical, with or without swollen apices 9

– Dorsal setae spine-like or slendrical with pointed apices 13

9. Antennae less than 8-segmented; tubular ducts absent on submarginal areas on dorsum 10

– Antennae 8-segmented; tubular ducts present on submarginal areas on dorsum (Fig. 5; Ben-Dov 1981: Fig. 2) .... *C. gymnospori* (Green)

10. Submarginal tubercles present; dorsal setae slightly swollen apically 11

– Submarginal tubercles absent; dorsal setae never swollen apically (Fig. 7) .... *C. latioperculatum* (Green)

11. Ventral thoracic tubular ducts present 12

– Ventral thoracic tubular ducts absent (Gill *et al.* 1977: Fig. 4) .... *C. capparidis* (Green)

12. Antennae 7-segmented; tibio-tarsal articulatory sclerosis present (Fig. 9; Zimmerman 1948: Fig. 161; De Lotto 1960: Fig. 5; Gill *et al.* 1977: Fig. 10) .... *C.viridis* (Green)

– Antennae 4-5-segmented; tibio-tarsal articulatory sclerosis absent (Fig. 3) .... *C. colemani* Kannan

13. Paraopercular pores present 14

– Paraopercular pores absent 15

14. Tubular ducts few, always present in mid-thoracic region, often between forelegs and rostrum: dorsal setae spinose with finely or bluntly pointed apices, distinctly differs from marginal setae (Fig. 6; De Lotto 1959: Fig. 4; Hodgson 1967: Fig. 1; Williams and Kosztarab 1972: pl. 7; Gill *et al.* 1977: Fig. 5) .... *C. hesperidum* (Linn.)

Tubular ducts numerous, confined to medio-submedian regions of head and thorax; dorsal setae slendrical with pointed apices, similar to marginal setae (Takagi 1975: Fig. 1) .... *C. formicarii* (Green)

15. Tibio-tarsal articulatory sclerosis present; dorsal setae large, strongly spinose (Fig. 4) .... *C. discrepans* (Green)

– Tibio-tarsal articulatory sclerosis absent; dorsal setae small, spine-like with finely or bluntly pointed apices (Avasthi and Shafee 1983: Fig. 1) .... *C. almoraensis* Avasthi and Shafee

Coccus acutissimus (Green)

Lecanium acutissimum Green 1896: 10; Ayyar 1930: 48.

Coccus acutissimus (Green): Fernald 1903: 168; Fletcher 1919: 293; Ferris *in* Zimmerman 1948: 295; Takahashi 1952: 15; Ali 1971: 21; Varshney 1985: 26.

The general appearance of the species as given in the original description is: "Very narrow, pointed in front and behind, of the shape and size of a carroway seed. Reddish brown to black" (Green 1896). Further, he mentioned that in this species antenna is 6-jointed and there is a single stigmatic spine. Gill *et al.* (1977) studied the syntype and found reduced antennae, 161-198 μ long, 3-segmented, sometimes with membranous divisions indicating 5 segments and 3 stigmatic spines. Further, they redescribed and illustrated this species in detail and mention its occurrence in India as well. They were of the opinion that it is not congeneric and the distinctive slender body with pointed extremities, dark coloration of older specimens and reduced appendages easily distinguish this species from other *Coccus* species in the New World.

Distribution: Tamil Nadu: Coimbatore.

Coccus adersi (Newstead) (Fig. 1)

Lecanium adersi Newstead 1917: 357; Ayyar 1930: 47.

Coccus adersi (Newstead): De Lotto 1959: 155; Ali 1971: 21; Varshney 1985: 26.

Adult female (Fig. 1 A): Mounted specimens irregularly ovate, 4.59-6.12 mm long, 3.23-3.4 mm wide. Dorsum with a few small oval or circular translucent areas on submedian regions of

abdomen. Setae (Fig. 1 B) minute, spiniform and evenly distributed. Para-opercular pores and submarginal tubercles absent. Tubular ducts (Fig. 1 C) few, present in a fairly regular series on submargins of the body. Anal plates (Fig. 1 D) together oval, with cephalolateral and caudolateral margins fused together to form a continuous curve; each plate with three apical and four subapical setae; anal fold with two pairs of small fringe setae. Marginal setae (Fig. 1 E) small, curved, dilated apically and set very close to each other, 33-43 setae between anterior and posterior stigmatic clefts. Stigmatic clefts well developed, each with 18-24 cylindrical setae of variable lengths and diameter (Fig. 1 F).

Venter with thin spinose setae (Fig. 1 G) arranged submarginally and a few scattered irregularly on median region. Inter-antennal and prevulvular setae 2 pairs each. Quinquelocular pores (Fig. 1 I) few, near cleft and spiracular opening but not in a continuous row. Multilocular pores absent. Tubular ducts (Fig. 1 H) few, near genital opening only. Eyes absent. Antennae 7-segmented (Fig. 1 J) but sometimes 6-segmented (Fig. 1 K), with a pseudo-articulation on third segment, 0.4-0.44 mm long. Spiracles normal. Legs well developed, without tibio-tarsal articulatory sclerosis; claws simple, digitules longer than claw and clubbed apically (Fig. 1 L); dimensions of fore, mid and hind legs: trochanter + femur (0.24 - 0.25: 0.25-0.27: 0.28-0.29 mm), tibia (0.15-0.16: 0.16-0.18: 0.18-0.19 mm) and tarsus (0.11: 0.12: 0.12 mm) respectively.

Material examined: 1 slide with 2 adult females, labelled: *Lecanium adersi* Newstead, from Mango, Zanzibar, 1913, R. Newstead (BMNH).

This species seems not to be congeneric and differs from all known species of *Coccus* by its having numerous stigmatic spines. Further, the presence of oval anal plates, shows its close relationship with *C. bicruciatus* (Green).

Distribution: Tamil Nadu: Coimbatore.

Coccus almoraensis Avasthi & Shafee

Coccus almoraensis Avasthi and Shafee 1983 : 389, 1988: 43.

Material examined: Holotype female, Paratypes 3 females. INDIA: Uttar Pradesh, Almora, on wild plant, 7 June 1978; 5 females paratypes, Bihar, Arrah, on *Mangifera indica* L., 12 November 1979 (*R.K. Avasthi*) (ZMAMU).

Distribution: Uttar Pradesh: Almora; Bihar: Arrah.

Coccus bicruciatus (Green) (Fig. 2)

Lecanium bicruciatum Green 1904 214 Ayyar 1930: 50.

Coccus bicruciatus (Green): Green 1904:248; Ferris 1921: 212; De Lotto 1957 : 299; Ali 1971 : 22; Varshney 1985 : 26.

Adult female (Fig. 2 A): Mounted specimens more or less oval, 3.23-5.61 mm long; 2.14-3.81 mm wide. Dorsum with some irregular shaped pale areas on submedian areas of postsoma, each with a variable number of pores (Fig. 2 C). Setae (Fig. 2 B) minute and spiniform. Para-opercular pores and submarginal tubercles absent. Anal plates (Fig. 2 E) together oval, with cephalolateral and caudolateral margins fused together to form a continuous curve; each plate with three apical and one subapical setae; anal fold with two pairs of small fringe setae. Marginal setae (Fig. 2 F) small, curved, bifid, fimbriate apically and set close to each other, 20-35 setae between anterior and posterior stigmatic clefts. Stigmatic clefts well developed each with a large deeply chitinized rim and three spines, median spine about as equal as or 1.5 times longer than laterals (Fig. 2 D).

Venter with thin spinose setae (Fig. 2 G) arranged irregularly. Inter-antennal and prevulvular setae 1-2 and 2-3 pairs respectively. Quinquelocular pores (Fig. 2 I) in a row between spiracles and stigmatic clefts. Multilocular pores absent. Tubular ducts (Fig. 2 H) few around genital opening only. Eyes absent. Antennae (Fig. 2 J, K) 6-7-segmented, 0.35-0.39 mm long. Spiracles normal. Legs well developed, without tibiotarsal articulatory sclerosis; claws simple, digitules longer than claw and flattened apically; tarsal digitules long, slender and clubbed at apices (Fig. 2 L); dimensions of fore, mid and hind legs: trochanter + femur (0.22-0.23: 0.23-0.25: 0.24-

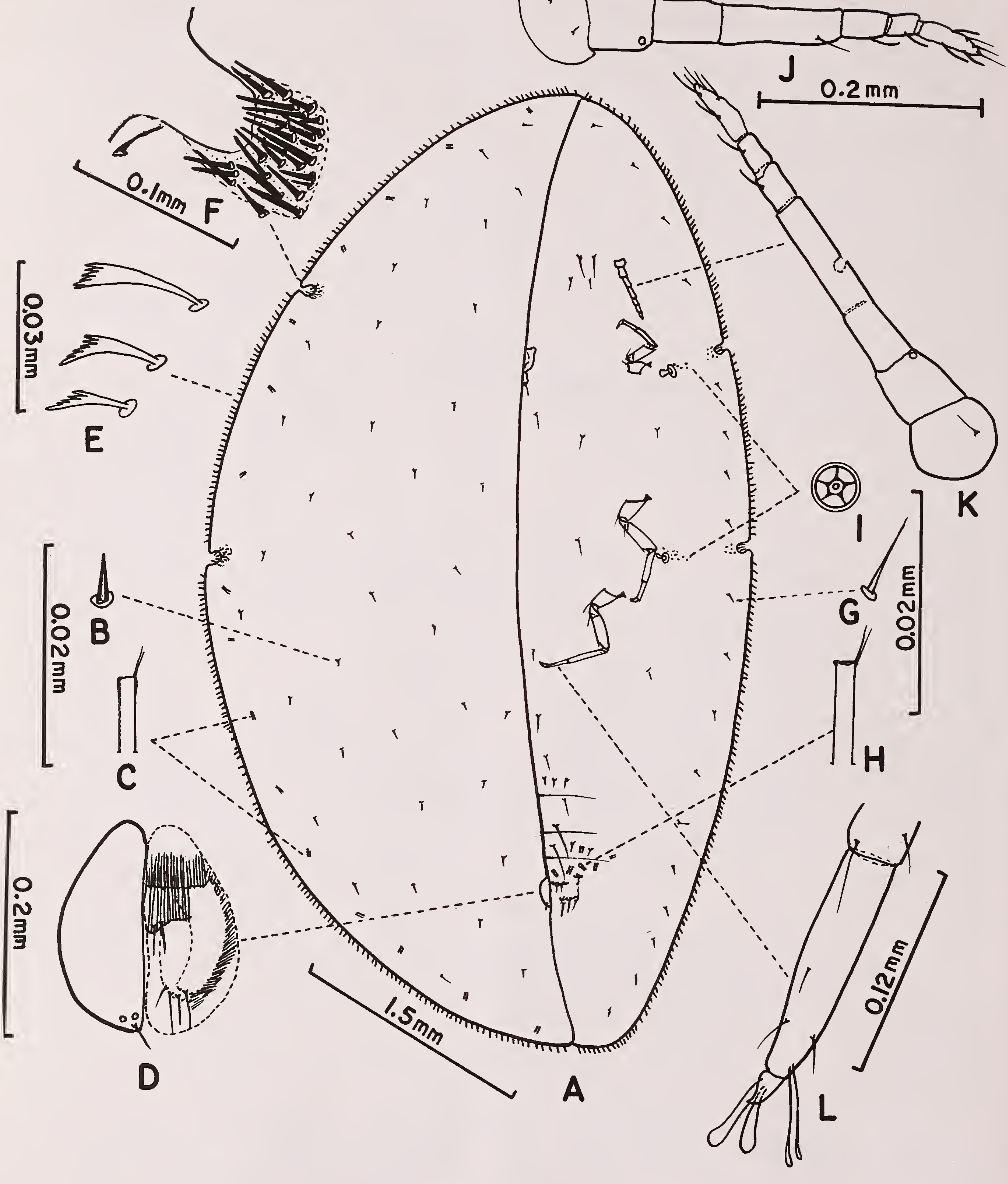

Fig. 1. *Coccus adersi* (Newstead), female. See text for explanations.

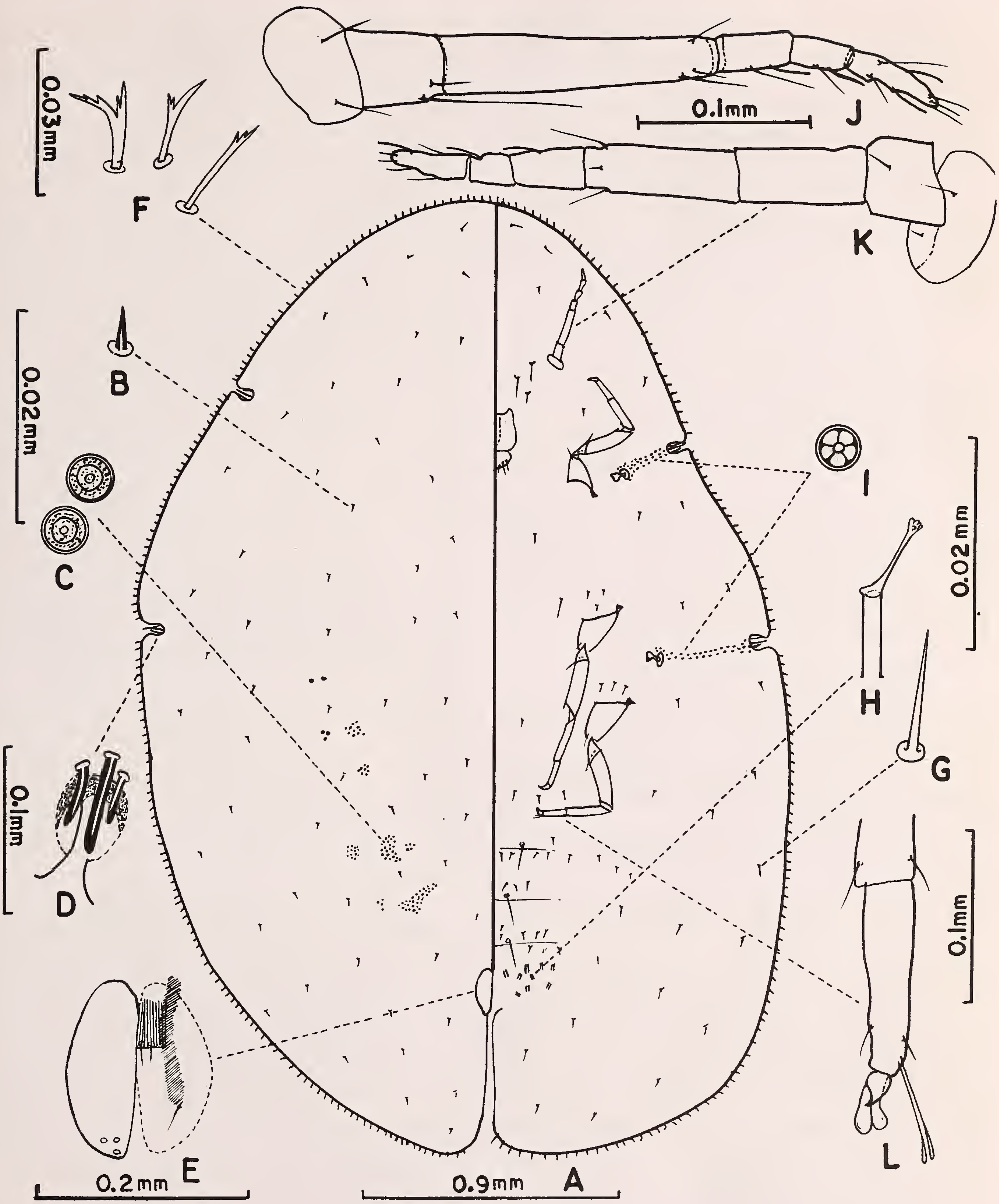

Fig. 2. *Coccus bicruciatus* (Green), female. See text for explanations.

0.27 mm), tibia (0.12-0.13 : 0.14-0.15 : 0.15 mm) and tarsus (0.1-0.11 : 0.11-0.12: 0.11-0.12 mm) respectively.

Material examined: 1 slide with 3 adult females, labelled: *Coccus bicruciata* (Green), on *Crpporis mitohrili*, Aug. 12, 1931; Chinrhilla. (NMNH).

The presence of oval shaped anal plates shows its close resemblance with *C. adersi* and easily dinstinguishes it from other *Coccus* species.

Distribution: Tamil Nadu: Tirunelveli.

Coccus capparidis (Green)

Lecanium capparidis Green 1904 : 187.
Lecanium (Coccus) capparidis Green 1937 : 299.
Coccus capparidis (Green) Green 1904: 248; Ali 1971 : 22; Gill *et al.* 1977 : 16; Varshney 1985 : 26.

Gill *et al.* (1977) redescribed and illustrated this species in detail and were of the opinion that "*C. capparidis* apparently belongs with the groups of species centered around *C. hesperidum*"

Distribution: West Bengal: Darjeeling.

Coccus colemani Kannan (Fig. 3)

Coccus colemani Kannan, 1918: 135; Green 1918: 149; Ali 1971: 23.
Coccus viridis var. *colemani* Kannan: Puttarudriah and Channabasavanna 1953: 252; Varshney 1985 : 26.
Lecanium (Coccus) colemani Kannan: Ayyar 1930 : 49.

Adult female (Fig. 3A): Mounted specimens oval, 1.84-2.55 mm long, 1.12-1.53 mm wide. Dorsum with small slightly oval pale areas (Fig. 3 F). Setae (Fig. 3 B) cylindrical, slightly swollen apically and scattered irregularly. Para-opercular pores generally absent; sometimes 2-3 pores (Fig. 3 D) present anterior to anal plates. Submarginal tubercles (Fig. 3 C) 6-10 in number. Anal plates (Fig. 3 E) together quadrate with cephalolateral margins distinctly shorter than caudolateral margins, each plate with three apical and two subapical setae; anal fold with two pairs of long fringe setae. Marginal setae (Fig. 3 G) small, fimbriate, few bifid apically; 9-11 setae between anterior and posterior stigmatic clefts. Stigmatic clefts well developed, each with three spines; median spine long, curved about 2.5 times longer than laterals (Fig. 3 H, I).

Venter with thin spinose setae (Fig. 3 J) arranged submarginally and scattered irregularly on median and submedian areas. Inter-antennal and prevulvular setae 2 and 3 pairs respectively. Quinquelocular pores (Fig. 3 L) few, 18-25 in number, arranged in a row between spiracles and stigmatic clefts. Multilocular pores (Fig. 3 M) few near genital region and extend upto preceding six abdominal segments and decrease in number. Tubular ducts (Fig. 3 K) in mid-thoracic region and a few near genital region. Eyes absent. Antennae (Fig. 3 N) 4-5-segmented, 0.23-0.25 mm long. Spiracles normal. Legs well developed, almost subequal, without tibio-tarsal articulatory sclerosis; tibia and tarsus fused together, sometimes indistinctly separated; claws simple, digitules longer than claw and clubbed apically; tarsal digitules long, slender, clubbed at apices (Fig. 30); dimensions of fore, mid and hind legs: trochanter + femur (0.12-0.14 mm), tibia + tarsus (0.12-0.16 mm).

Material examined: 1 slide with 3 adult females, labelled: *Coccus colemani* Kannon, on *Coffea arabica*, Coffee farm, Balehonnur, Mysore, India, R.H. Le Pley, Col., 29 July1957. 1 slide with 1 adult female labelled: *Coccus colemani* Kannon, on Vunindawa, Vitileva, Fijii, M.L.H. Krauss Coll. (NMNH).

The general appearance of this species as given in the original description is: "Colour pale yellow to greenish yellow, shape oval, the anterior end being narrower but is liable to variation in specimens fixed on the sides of veins of leaves in which the anterior end is more or less acuminate, and either the right or the left side may be shortened and straight" (Kannan 1918). It was considered a mutant of *C. viridis* by the original author, but Green (1918) remarked "it seems questionable if there is sufficient justification for the erection of this new species." Ali (1971) catalogued it as a distinct species whereas Varshney (1985) listed it as a variety of *C. viridis*.

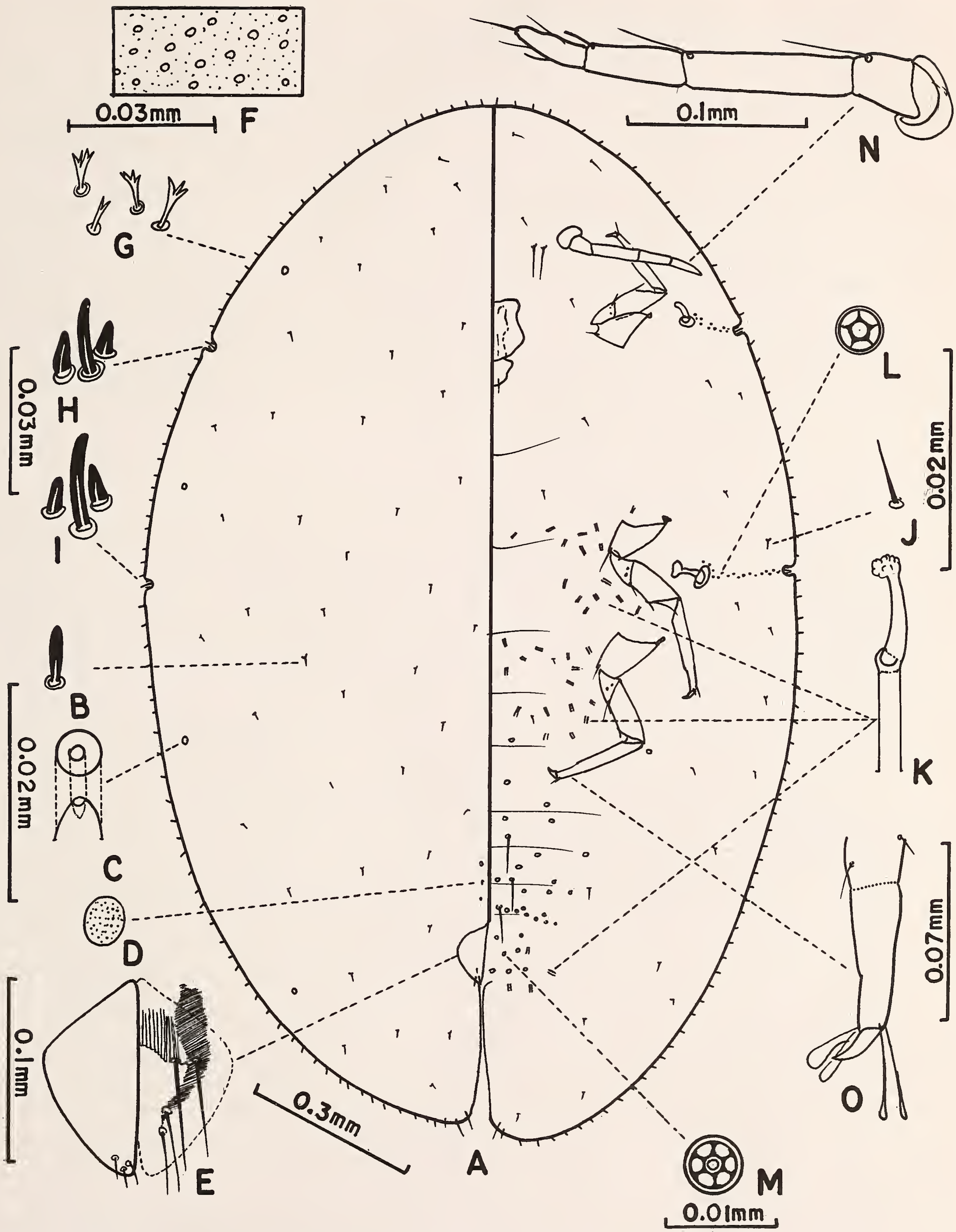

Fig. 3. *Coccus colemani* Kannan, female. See text for explanations.

The study of Indian and Fiji material supports Green (1918) and Ali (1971) in recognising it as a distinct species which differs from *C. viridis* in key characters.
Distribution: Karnataka: Mysore.

Coccus discrepans (Green) (Fig. 4)

Lecanium discrepans Green 1904: 204; Fletcher 1921: 19; Misra 1923: 348; Ayyar 1930: 50.
Coccus discrepans (Green): Morrison 1921 : 654; Das & Ganguli 1961: 247; Ali 1971: 23; Varshney 1985: 26.
Saissetia discrepans (Green), 1904: 248.
Adult female (Fig. 4 A): Mounted specimens irregularly oval, 2.38 mm long, 1.69 mm wide. Dorsal setae (Fig. 4 B) large, spinose, scattered irregularly. Para-opercular pores absent. Submarginal tubercles (Fig. 4 C) eight in number. Anal plates (Fig. 4 D) together quadrate with cephalolateral margins about as long as caudolateral margins, each plate with 3 apical and 1 subapical seta; anal fold with 2 pairs of fringe setae. Marginal setae (Fig. 4 E) small, simple, few bifid; a pair of marginal setae on apex of cleft fimbriate; 7-11 setae between anterior and posterior stigmatic clefts. Stigmatic clefts well developed with three spines; median spine broken, but available spines about as long as or twice the length of lateral spines (Fig. 4 F).

Venter with thin setae (Fig. 4 G) sparsely arranged. Inter-antennal and prevulvular setae two and three pairs respectively. Quinquelocular pores (Fig. 4 I) 8-22 in number, arranged in a row one pore wide between stigmatic clefts and spiracles. Multilocular pores (Fig. 4 J) few near genital region and on preceding one or two abdominal segments. Tubular ducts (Fig. 4 H) few near middle coxae and sparse between middle legs. Eyes absent. Antennae (Fig. 4 K) broken, visible up to five segments. Spiracles normal. Legs well developed, with a tibio-tarsal articulatory sclerosis and without free articulation; claws simple, digitules unequal; tarsal digitules long, slender with clubbed apices (Fig. 4 L); dimensions of fore, mid and hind legs: trochanter + femur (0.13: 0.14: 0.14 mm), tibia (0.09: 0.11: 0.1 mm) and tarsus (0.06 : 0.07: 0.07 mm) respectively.
Material examined: 1 slide with single adult female, poor in condition, labelled: *Lecanium discrepans* Green, from nest of ants *Cremastogaster dohrni*, on tea plant, Pundaluoya, Ceylon part of type material (NMNH).

Morrison (1921) justified the placement of this species in *Coccus* instead of *Saissetia* as orginally listed by the describer of the species. The common red ant *Oecophylla smaragdina* has been found in constant attendance on this species (Das and Ganguli 1961).
Distribution: Assam: Gauhati, Tocklai; Bihar: Pusa; Andhra Pradesh: Godavari; Kerala: Travancore.

Coccus formicarii (Green)

Lecanium formicarii Green 1896: 10; Ayyar 1930: 47; Ferris 1936: 14; Takahashi 1952: 16.
Lecanium globulosum Maskell 1897b: 243; Fernald 1903: 212.
Saissetia formicarii (Green): Fernald 1903 : 202; Das and Ganguli 1961: 247; Ali 1971 : 44.
Coccus formicarii (Green); Takagi 1975: 33; Varshney 1985: 26.

This interesting form is said to be found enclosed in the nests of ants especially the ant *Cremastogaster dohrni* (Ayyar 1930). In the absence of attendant ants, the coccid disappears (Das and Ganguli 1961). The general appearance of this species as given in the original description is on stems of tea and other shrubs, always sheltered by nests of a small brown ant (*Cremastogaster* sp.). Highly convex, almost globular, dull brown. (Green 1896). Takagi (1975) redescribed and illustrated the species in detail and placed it in *Coccus* instead of *Saissetia*. Further, he doubted that this species was congeneric to *C. hesperidum* L. It is different from all species of *Coccus* in having numerous tubular ducts in medio-submedian regions of the head and thorax.
Distribution: Karnataka: Mysore; plains of north-east India.

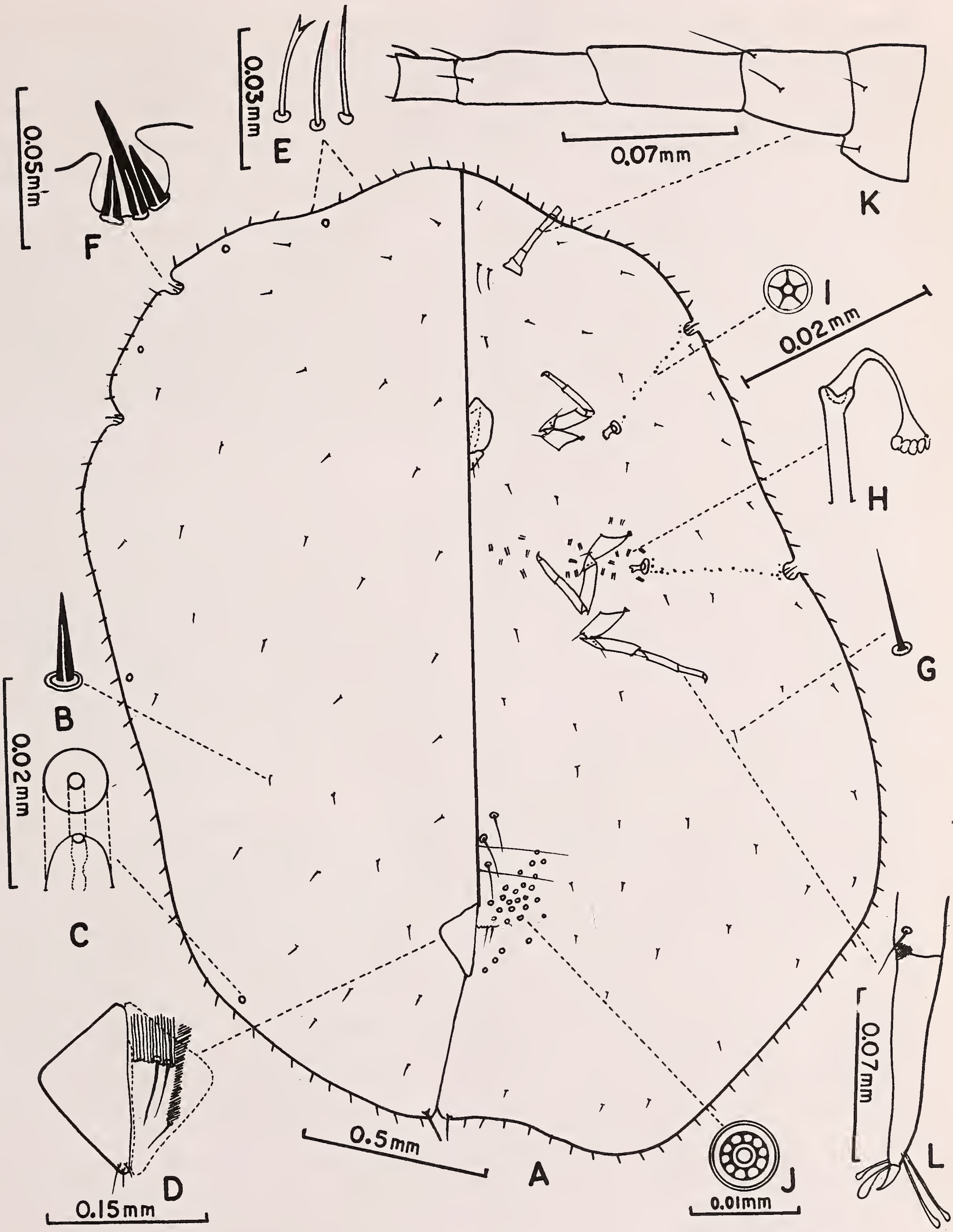

Fig. 4. *Coccus discrepans* (Green), female. See text for explanations.

Coccus gymnospori (Green) (Fig. 5)

Lecanium gymnospori Green 1908: 29; Ayyar 1930: 48.
Coccus gymnospori (Green): Sanders 1909: 45; Ali 1971: 24; Ben-Dov 1981: 651; Varshney 1985: 26.

Adult female (Fig. 5 A): Mounted specimens usually oval, 2.42- 4.59 mm long, 1.56-3.23 mm wide. Dorsum with numerous small circular or oval pale areas (Fig. 5 F). Dorsal setae (Fig. 5 B) cylindrical with slightly narrowing apices. Paraopercular pores absent. Submarginal tubercles (Fig. 5 C) 6-11 in number. A few tubular ducts (Fig. 5 N) present towards margin. Anal plates (Fig. 5 M) together quadrate, with cephalolateral margins about as long as caudolateral margins; each plate with four apical (three dorsal, 1 ventral) and three subapical setae; anal fold with two pairs of long fringe setae. Marginal setae (Fig. 5 D) stout, simple, few bifid and fimbriate at apices; 13-23 setae between anterior and posterior stigmatic clefts. Stigmatic clefts well developed, each with three spines; median spine long, almost straight (Fig. 5 E).

Venter with thin spinose setae (Fig. 5 G) arranged towards margin and sparse on median and submedian areas. Inter-antennal and prevulvular setae two and three pairs respectively. Quinquelocular pores in a row between stigmatic clefts and spiracles. Multilocular pores (Fig. 5 J) near genital region and very few on preceding 2 abdominal segments. Tubular ducts (Fig. 5 H) few, present between meso- and metacoxae, in a transverse band between mesocoxae, few ducts in between dorsum and fore coxae. Eyes present. Antennae (Fig. 5 K) 8-segmented, 0.32-0.36 mm long. Spiracles normal. Legs well developed with free tibio-tarsal articulation and well developed articulatory sclerosis; claws simple, digitules longer than claw and clubbed apically; tarsal digitules slender and clubbed apically (Fig. 5 L); dimensions of fore, mid and hind legs: trochanter + femur (0.16-0.2: 0.18-0.2: 0.2-0.23 mm), tibia (0.11-0.12: 0.12-0.15: 0.15-0.16 mm) and tarsus (0.06-0.08: 0.07-0.08: 0.08-0.11 mm) respectively.

Material examined: 1 slide with 4 adult females and 1 immature form labelled: *Coccus gymnospori*, on Cacao, Kandy, Ceylon, Aug. 29, 1954, Dr. D.E. Dardy Coll. 2 slides each with 1 adult female labelled: *Coccus gymnospori* (Green), on *Gymnosporia montana*, Poona, India, Coll. E.E. Green (part of type) (NMNH).

The general appearance of this species as given in the original description is: "Adult female (dried examples), deep ochreous, sometimes mottled with reddish brown. Eyes black. Elongate oval; shrivelled and wrinkled when dry. Trace of an irregular median carina" (Green 1908).

Distribution: Andhra Pradesh: Guntur; Maharashtra: Poona.

Coccus hesperidum Linn. (Fig. 6)

Coccus hesperidum Linn. 1758: 455; Fernald 1903: 168; Zimmerman 1948: 301; Takahashi 1952: 14; Borchsenius 1957: 294; De Lotto 1959: 160; Ghose 1961: 65; Das and Ganguli 1961; 248; Ganguli and Ghose 1964: 358; Boratynsky and Williams 1964: 108; De Lotto 1965: 192; Hodgson 1967: 4; Ali 1971: 24; Williams and Kosztarab 1972: 55; Gill *et al.* 1977: 18; Varshney 1985: 26; Avasthi and Shafee 1988: 43.
Chermes hesperidum (Linn.), Geoffroy 1762: 505.
Calypticus hesperidum (Linn.): Costa 1835: 8.
Calypticus laevis Costa 1835: 11.
Coccus patelliformis Curtis 1843: 517.
Chermes louri Boisduval 1867: 340.
Lecanium angustatum Signoret 1873: 398.
Lecanium maculatum Signoret 1873: 400.
Lecanium hesperidum (Linn.): Burmeister 1835: 69; Newstead 1903: 78; Green 1904: 188, 197, 1908: 30; Misra 1923: 347: Ayyar 1930: 46.
Lecanium alienum Douglas 1886: 77.
Lecanium depressum var. *simulans* Douglas 1887a: 28
Chermes aurantii Alfonso, Targioni-Tozzetti 1891: 10.
Lecanium minimum Newstead 1892: 141.
Lecanium assimile var. *amaryllis* Cockerell 1893a: 53.

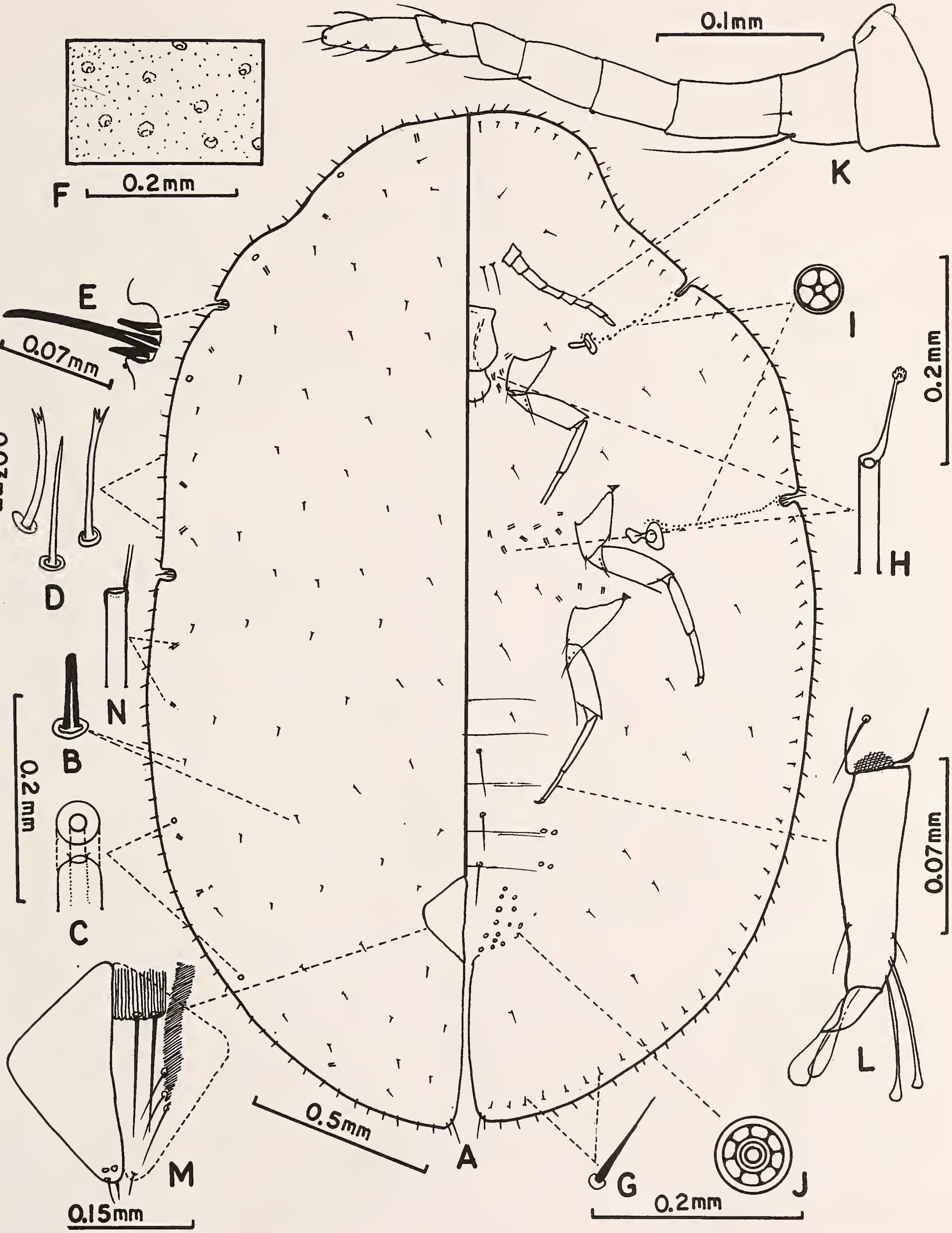

Fig. 5. *Coccus gymnospori* (Green), female. See text for explanations.

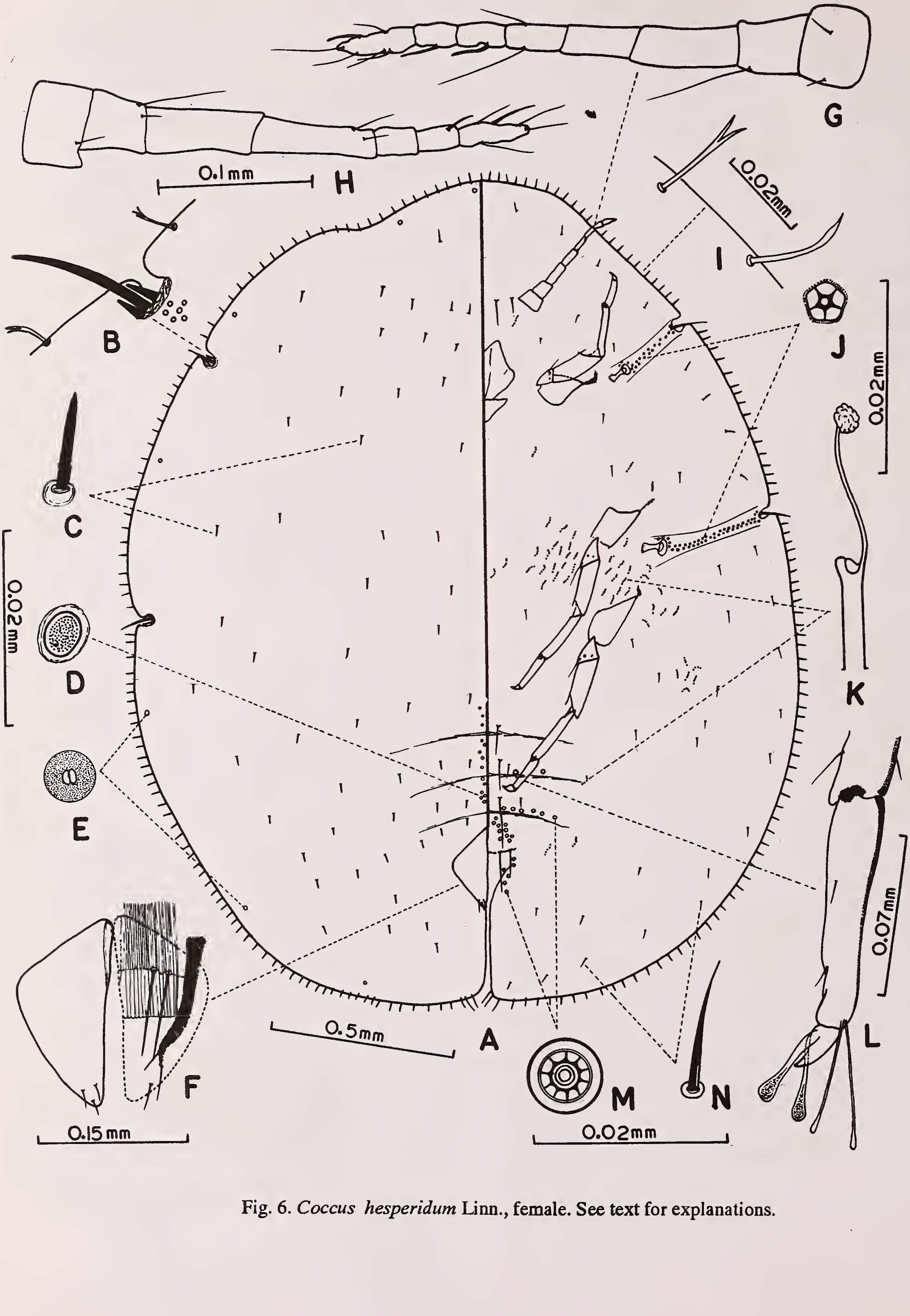

Fig. 6. *Coccus hesperidum* Linn., female. See text for explanations.

Lecanium terminaliae Cockerell 1893b: 254.
Lecanium ceratoniae Gennadius 1895: cclxxvii.
Lecanium nanum Cockerell 1896: 19.
Lecanium flaveolum Cockerell 1897: 52, 53.
Lecanium minimum var. *pinicola* Maskell 1897a: 310.
Lecanium ventrale Ehrhorn 1898: 245.
Lecanium (Calymnatus) hesperidum pacificum Kuwana 1902: 30.
Lecanium hesperidum var. *minimum* Newstead 1903: 85.
Lecanium signiferum Green 1904: 197.
Lecanium punctuliferum Green 1904: 205.
Lecanium mauritiense Mamet 1936: 96.

The synonyms listed above were obtained from Gill *et al.* (1977).

Material examined: 6 females INDIA: Jammu & Kashmir, Srinagar, on wild plant, 19 June 1977; 3 females, Uttar Pradesh, Aligarh, on *Mangifera indica* L., 25 February 1979; 3 females, Tamil Nadu, Coimbatore, on wild plant, 29 March 1979 (*R.K. Avasthi*). 3 females, Uttar Pradesh, Aligarh, on *Ficus infectoria* Wild., 13 November 1979 (*S.A. Shafee*) (ZMAMU).

The detailed redescription and illustration of this species are given by Zimmerman (1948), De Lotto (1959), Hodgson (1967), Williams and Kosztarab (1972), Gill *et al.* (1977). In this species the antenna is 7-segmented, but occasionally 8-segmented. Free tibio-tarsal articulation is generally absent, but observed in some specimens though there is well developed articulatory sclerosis. Occasionally the tubular ducts are also present posterior to hind coxae.

Distribution: Bihar: Pusa; Kerala: South Malabar; Andhra Pradesh: Godavari; Tamil Nadu: Coimbatore; Karnataka: Bangalore; Gujarat: Surat: West Bengal; Goa; Tripura; Jammu & Kashmir: Srinagar; Uttar Pradesh: Aligarh.

Coccus kosztarabi Avasthi & Shafee

Coccus kosztarabi Avasthi & Shafee 1983: 389; 1988: 44.

Material examined: Holotype female, Paratypes 6 females, INDIA: Karnataka, Tumkur, on *Mangifera indica* L., 8 April 1979 (*R.K. Avasthi*). (ZMAMU).

This species differs from all Indian species in having numerous setae on dorsum of anal plate.

Distribution: Karnataka: Tumkur.

Coccus latioperculatum (Green) (Fig. 7)

Lecanium latioperculatum Green 1922: 1022; Ayyar, 1930: 50.
Coccus latioperculatum (Green): Ali 1971: 26; Varshney 1985: 26.

Adult female (Fig. 7 A): Mounted specimens oval in shape, 1.53-1.91 mm long, 0.98-1.39 mm wide. Dorsum with small pale areas (Fig. 7 E). Dorsal setae (Fig. 7 B) cylindrical, scattered irregularly. Para-opercular pores (Fig. 7 C) very few, up to 10 or absent. Submarginal tubercles absent. Anal plates (Fig. 7 D) together roughly quadrate with cephalolateral margins slightly longer than caudolateral margins, each plate with 3 apical and 1 subapical setae; anal fold with 2 pairs of fringe setae. Marginal setae (Fig. 7 F) small, curved, bifid and fimbriate, 4-11 setae between anterior and posterior stigmatic clefts; stigmatic clefts well developed, each with 2-4 spines, generally with 3 (Fig. G-H).

Venter with thin spinose setae (Fig. 7 I) arranged submarginally and scattered irregularly on median and submedian areas. Inter-antennal and prevulvular setae 2 pairs each. Quinquelocular pores (Fig. 7 K) few, 11-15 in number arranged in a row one pore wide between cleft and spiracles. Multilocular pores (Fig. 7 L) few, confined to genital opening only. Tubular ducts (Fig. 7 J) few present near mid coxae, sometimes near rostrum. Eyes absent. Antennae (Fig. 7 M) 7-segmented, 0.22-0.24 mm long. Spiracles normal. Legs well developed with free tibio-tarsal articulation and well developed tibio-tarsal articulatory sclerosis; claws simple, digitules longer than claw and rounded apically; tarsal digitules slendrical and clubbed at apices (Fig. N); dimensions of fore, mid and hind legs: trochanter + femur (0.11-0.14 : 0.12-0.13: 0.12-0.14 mm), tibia (0.07: 0.07: 0.07 mm), and tarsus (0.04: 0.05: 0.06 mm) respectively.

Material examined: 1 slide with 4 adult females,

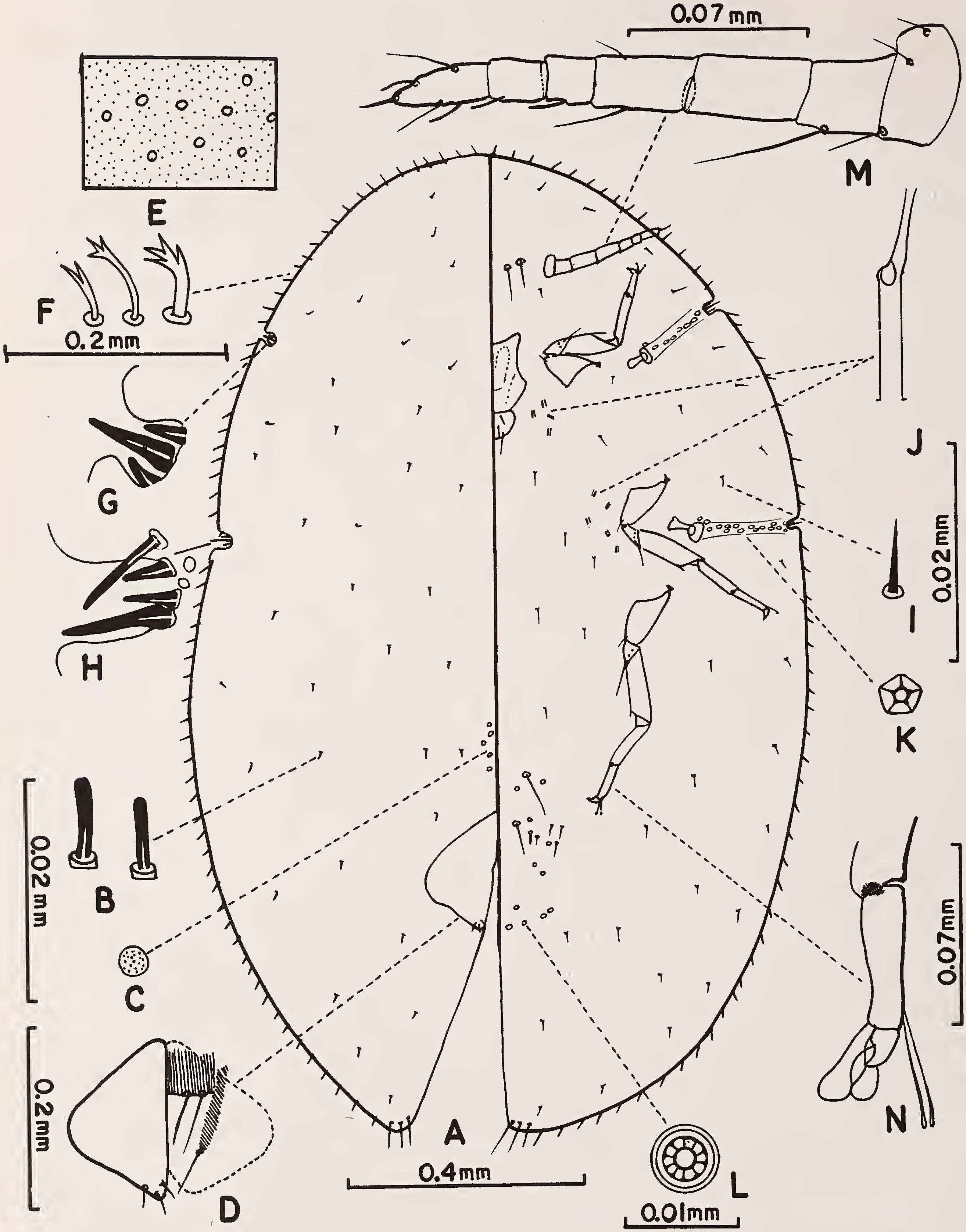

Fig. 7. *Coccus latioperculatum* (Green), female. See text for explanations.

labelled: *Coccus latioperculatus* (Green); *Spondias mangifera*, Matala, Ceylon, Sept. 29, 1954. H.A. Bess. (NMNH).

The general appearance of this species as given in the original description is "Adult female broadly ovate, moderately convex; derm soft, wrinkling when dry; colour yellowish fulvous" (Green 1922).

Distribution: Tamil Nadu: Coimbatore.

Coccus longulus (Douglas)

Lecanium longulum Douglas 1887b: 97; Green 1908: 30; Ayyar 1930: 46.
Lecanium angustatum Signoret: Douglas 1887a: 25 (Misidentification).
Lecanium chirimoliae Maskell 1890: 137; Newstead 1903: 86; Green 1904: 221.
Lecanium ficus Maskell 1897b: 243, Ferris in Zimmerman 1948: 300.
Coccus longulum (Douglas): Kirkaldy 1902: 106.
Coccus longulus (Douglas): Fernald 1903: 171; Green 1904: 248; Ben-Dov 1977: 89; Varshney 1985: 26: Avasthi and Shafee 1988: 44.
Lecanium frontale Green 1904: 192.
Lecanium kraunhiarum Lindinger 1928: 107.
Lecanium wistariae Brain 1920: 8; De Lotto 1957: 301.
Parthenolecanium wistaricola Borchsenius 1957: 349 (as *nom. nov.); De Lotto 1965: 192.*
Lecanium (Coccus) Celtium Kuwana 1909: 162.
Coccus elongatus (Signoret): Zimmerman 1948: 300; De Lotto 1965: 192.

Material examined: 2 females INDIA: Tamil Nadu, Coimbatore, on *Thuja compacta*, 29 March 1979 *(R.K. Avasthi)* (ZMAMU).

The synonymy of species is taken from Ben-Dov (1977) and Gill *et al.* (1977). Further, they redescribed and illustrated this species in detail. The Indian material resembles in all respects these descriptions and illustrations.

Distribution: Assam: Sonari; Andhra Pradesh: Godavari; Karnataka: Bangalore; Tamil Nadu: Coimbatore.

Coccus ophiorrhizae (Green) (Fig. 8)

Lecanium ophiorrhizae Green 1896: 10; Ayyar 1930: 49.
Coccus ophiorrhizae (Green): Fernald 1903: 173; Green 1904: 248; Ali 1971: 27; Varshney 1985: 26.

Adult female (Fig. 8 A): Mounted specimens elongate elliptical in shape, 2.38 mm long, 1.15 mm wide. Dorsal setae (Fig. 8 B) small, cylindrical, scattered irregularly. Pre-opercular pores absent. Submarginal tubercles (Fig. 8 C) 6 in number, absent in cephalic region. Anal plates together quadrate with cephalolateral margins distinctly shorter than caudolateral margins; each plate with three apical and two subapical setae; anal fold with two pairs of fringe setae. Marginal setae (Fig. 8 E) small, simple, 13 setae between anterior and posterior stigmatic clefts; stigmatic clefts well developed with three spines; median spine long, more than twice the length of lateral spines (Fig. 8 F).

Venter with a few thin spinose setae present on median region of body. Inter-antennal and prevulvular setae two and three pairs respectively. Quinquelocular pores (Fig. 8 G) present in a row between stigmatic clefts and spiracles. Multilocular pores (Fig. 8 H) few around genital opening and on preceding two or three abdominal segments. Tubular ducts absent. Antennae 7-segmented (Fig. 8 I), sometimes 8-segmented with pseudo-articulation on fourth segment (Fig. 8 J), 0.28-0.29 mm long. Spiracles normal. Legs well developed with a tibio-tarsal articulatory sclerosis and without free articulation. Claw simple, digitules much longer than claw and flattened apically; tarsal digitules long and slender with clubbed apices (Fig. 8 K); dimensions of fore, mid and hind legs : trochanter + femur (0.16 : 0.17: 0.17 mm), tibia (0.12 : 0.12: 0.13 mm) and tarsus (0.07 : 0.08: 0.09 mm) respectively.

Material examined: 1 slide with single adult female, labelled: *Lecanium ophiorrhizae* Green, from *Ophiorrhiza pectinata*, Pundaluoya, Ceylon (Co-type) (BMNH).

The general appearance of this species as given in original description is "Oblong, pointed in front. Pale fulvous with dark reddish, reticulated pattern" (Green 1896).

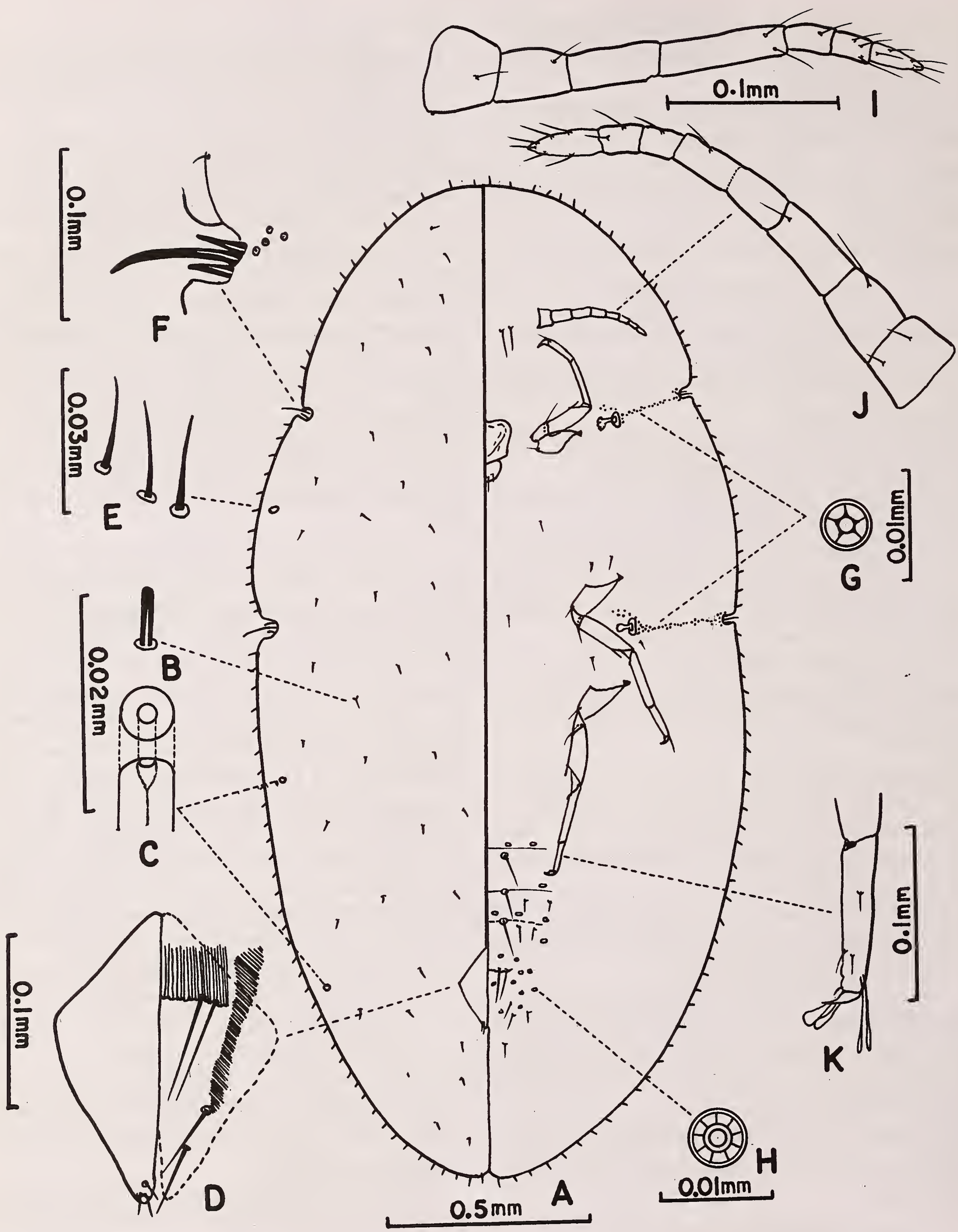

Fig. 8. *Coccus ophiorrhizae* (Green), female. See text for explanations.

Distribution: Andhra Pradesh: Kurnool (Ayyar 1930).

Coccus ramakrishnai (Green)

Lecanium ramakrishnai Green *in* Ayyar 1930: 47.
Coccus ramakrishnai (Green): Varshney 1985: 26.

Green in Ayyar (1930) recorded this species from Kothapetta (Godavary district) and described it as "The adult scales have a bluish black colour, and in shape the scale is more or less conical. The young insects are of a pale yellowish brown colour". Recently, Varshney (1985) listed it as a valid species in the genus *Coccus*. We were not able to trace further references to this species except those listed above, or material for study. The available description is inadequate and therefore the species is not included in the key and the status of the species is only provisionally accepted here.

Coccus viridis (Green) (Fig. 9)

Lecanium viridis Green 1886: 1-4; Fletcher 1919: 294; Ayyar 1930: 49.
Coccus viridis (Green): Fernald 1903: 174; Zimmerman 1948: 311; De Lotto 1959: 172; 1960: 397; Das and Ganguli 1961: 248; Ali 1971: 28; Gill *et al.* 1977: 37; Varshney 1985: 26; Avasthi and Shafee 1988: 44.

Adult female (Fig. 9 A): Mounted specimens oval to elongate oval, 2.38-2.71 mm long, 1.32-1.6 mm wide. Dorsal setae (Fig. 9 B) small, cylindrical, slightly swollen apically and sparsely distributed. Submarginal tubercles (Fig. 9 C) 9-11 in number. Para-opercular pores absent. Anal plates (Fig. 9 E) together quadrate, about as long as their combined width, each plate with three apical and two subapical setae; anal fold with two pairs of fringe setae. Marginal setae (Fig. 9 F) short, bifid and fimbriate apically, 7-10 setae between anterior and posterior stigmatic clefts. Stigmatic clefts well developed, each with 3 spines; median spine about twice the length of laterals (Fig. 9 G).

Venter with thin spinose setae, irregularly distributed. Inter-antennal and prevulvular setae 2-3 and 3 pairs respectively. Quinquelocular pores (Fig. 9 I) few, arranged in a row between cleft and spiracles. Multilocular pores (Fig. 9 J) present around genital opening and a few present on all abdominal segments. Tubular ducts (Fig. 9 H) present in bands on mid thoracic regions, a few near forelegs. Eyes absent. Antennae (Fig. 9 K) 7-segmented, 0.22-0.25 mm in length. Spiracles normal. Legs well developed, with tibio-tarsal articulatory sclerosis; claws simple, digitules longer than claw and clubbed at apices (Fig. 9 L); dimensions of fore, mid and hind legs: trochanter + femur (0.12-0.14: 0.14-0.15: 0.14-0.15 mm), tibia (0.09-0.1: 0.09-0.11: 0.09-0.1 mm), and tarsus (0.04-0.05: 0.04-0.05: 0.04-0.05 mm) respectively.

Material examined: 1 slide with 9 adult females labelled: *Lecanium viride* Green, from Coffee, Baudaravella, Ceylon (BMNH). 3 females, INDIA: Andhra Pradesh, Masulipatam, Kondapalle, on wild plant, 13 April 1979 (*R.K. Avasthi*) (ZMAMU).

Distribution: Assam: Tocklai; Karnataka: Mysore, Bangalore; Andhra Pradesh: Masulipatam.

Coccus watti (Green)

Lecanium watti Green 1900: 6.
Coccus watti (Green): Fernald 1903: 174; Rao and Kumar 1952: 3; Varshney 1985: 26.
Saissetia watti (Green): Das and Ganguli 1961: 247; Ali 1971: 45.

This species is redescribed and illustrated in detail by Rao and Kumar (1952).

Distribution: West Bengal; Assam.

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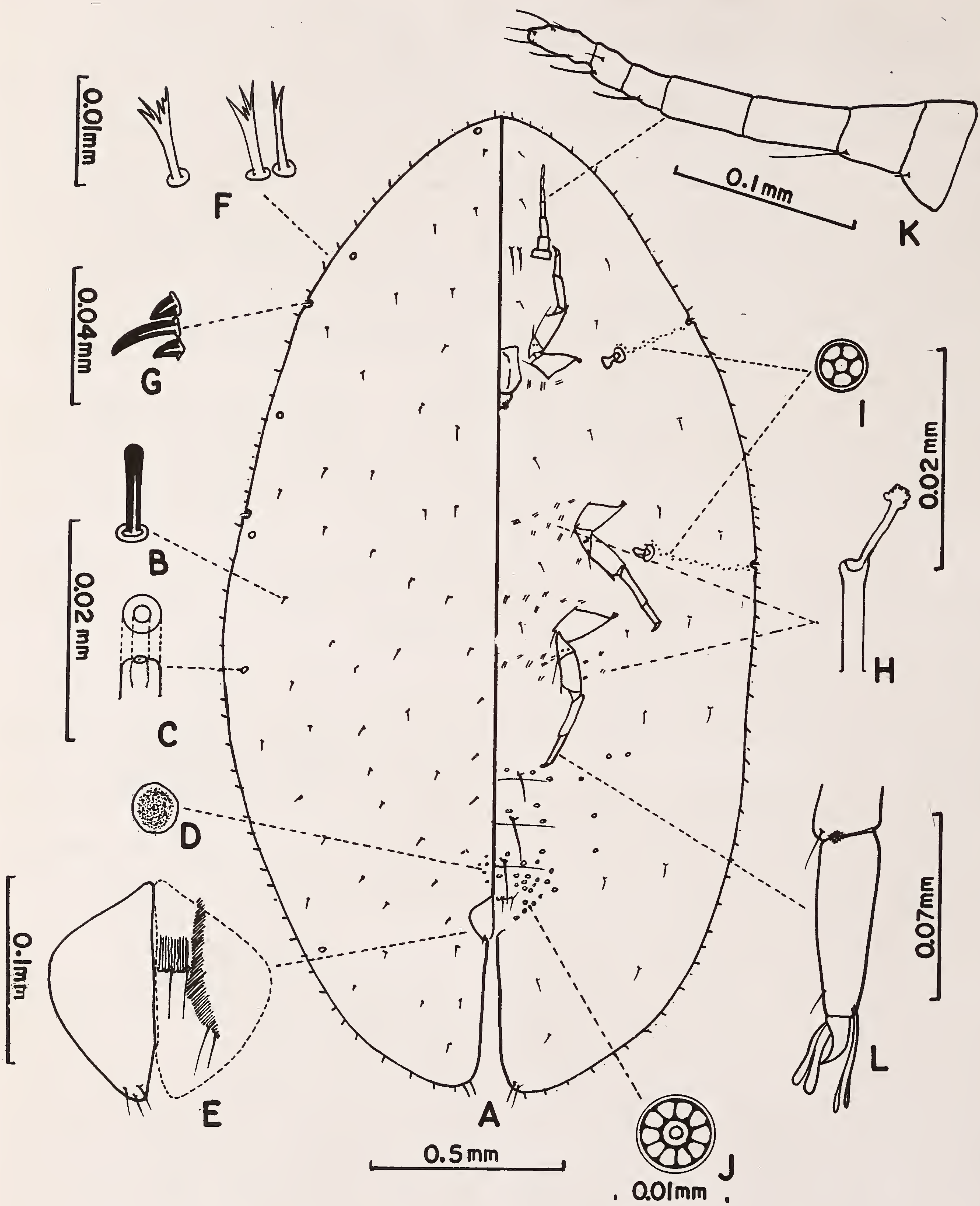

Fig. 9. *Coccus viridis* (Green), female. See text for explanations.

REFERENCES

ALI, S. M. (1971): A catalogue of the Oriental Coccoidea. part V. *Indian Mus. Bull. VI (2):* 7-82.

AVASTHI, R.K. & SHAFEE, S.A. (1983): Two new species of *Coccus* Linn. (Homoptera: Coccidae) from India. *Verh. SIEEC X. Budapest*, 389-392.

AVASTHI, R.K. & SHAFEE, S.A. (1988): Record of some Indian species of *Coccus* Linn. (Homoptera : Coccoidea). *Bull. Pure & Appl. Sci. 7A (1-2):* 42-44.

AYYAR, T.V.R. (1930): A contribution to our knowledge of South Indian Coccidae (Scales & Mealybugs). *Agr. Res. Inst. Pusa, Bul. 197* (1929): 73.

BEN-DOV, Y. (1977): Taxonomy of the long brown scale *Coccus longulus* (Douglas), stat. n. (Homoptera : Coccidae). *Bull. ent. Res. 67:* 89-95.

BEN-DOV, Y. (1981): A new species of *Coccus* (Hemiptera : Coccidae) from mango in Israel and a redescription of *C. gymnospori* (Green). *Bull. ent. Res., 71:* 649-654.

BOISDUVAL, A.M. (1867): Essai sur l'entomologie horticole. *Paris, Donnaud* 648 pp. (300-358).

BORATYNSKI, K. & WILLIAMS, D.J. (1964): A note on some British Coccoidea, with new additions to the British Fauna. *Roy. Ent. Soc. London., Proc. Ser. B: Taxonomy, 33:* 103-110.

BORCHSENIUS, N.S. (1957): Fauna of U.S.S.R., Homoptera, Coccidae (In Russian). *Akad. Nauk Zool. Inst. (n.s. 66)* 9.

BRAIN, C.K. (1920): Coccidae of South Africa-V. *Bull. Ent. Res. 11:* 1-41.

BURMEISTER, H. (1835): Scharlachlause. Schildlause. Coccina (Gallinsecta L.) *In Handb. der Ent.* v. 2. *abt.* 1. pp. 61-83.

COCKERELL, T.D.A. (1893a): Notes on *Lecanium*, with a list of the West Indian Species. *Amer. Ent. Soc. Trans. 20:* 49-56.

COCKERELL, T.D.A. (1893b): A list of West Indian Coccidae. *Inst. Jamaica Jour. 1:* 252-256.

COCKERELL, T.D.A. (1896): Preliminary diagnosis of new Coccidae. *Psyche, 7* (1894-1896) (supl.): 18-21.

COCKERELL, T.D.A. (1897): Notes on new Coccidae. 1. A new coccid pest of greenhouses. 2. A Japanese coccid quarantined at San Francisco. *Psyche, 8:* 52-53.

COSTA, O.G. (1828): Prospetto di una nuova divisione metodica del genere *Coccus* Linn. Lam. EC. *Napoli*, Dalla Tipografia Trani, 8 pp.

COSTA, O.G. (1835): Fauna del regno di Napoli, Famiglia de' Coccinigliferi, o de'gallinsetti. *Emitteri Napoli* 23 p.

CURTIS, J. (1843): *Coccus patellaeformis* (Curtis): The brown Limpet-scale. *Gard. Chron. No. 30:* 517-518.

DANZIG, E.M. & KERZHNER, I.M. (1981): *Coccus* Linn., 1758 and *Parthenolecanium* Sulc, 1908 (Insecta, Homoptera, Coccidae): proposed designation of type-species under the plenary powers.ZN(S) 2125. *Bull. Zool. Nomencl. 38 (2):* 147-152.

DAS, G.M. (1959): Observations on the association of ants with tea coccids. *Bull. ent. Res. 50(3):* 437-448.

DAS, G.M. & GANGULI, R.N. (1961): Coccids on tea in North East India. *Indian Jour. Ent. 23:* 245-256.

DE LOTTO, G. (1957): On some Ethiopian species of the genus *Coccus* (Homoptera: Coccoidea : Coccidae). *Ent. Soc. South Africa Jour. 20:* 295-314.

DE LOTTO, G. (1959): Further notes on Ethiopian species of the genus *Coccus* (Homoptera: Coccoidea: Coccidae). *Ent. Soc. South Africa Jour. 22:* 150-173.

DE LOTTO, G. (1960): The green scale of coffee in Africa South of the Sahara (Homoptera : Coccidae). *Bull. Ent. Res. 51:* 389-403.

DE LOTTO, G. (1965): On some Coccidae (Homoptera), chiefly from Africa. *Brit. Mus. (Nat. Hist.) Ent. Bul., 16:* 175-239.

DOUGLAS, J.W. (1886): Note on some British Coccidae (No. 4) *Ent. Monthly Mag. 23:* 77-82.

DOUGLAS, J.W. (1887a): Note on some British Coccidae (No. 7). *Ent. Monthly Mag. 24:* 21-28.

DOUGLAS, J.W. (1887b): Notes on some British Coccidae (No. 8). *Ent. Monthly Mag. 24:* 95-101.

EHRHORN, E.M. (1898): New Coccidae. *Canad. Ent.* 30: 244-246.

FERNALD, M.E. (1903): A catalogue of the Coccidae of the World. *Mass Agr. Expt. Sta. Spec. Bul. 88:* 360 pp.

FERRIS, G.F. (1921): Some Coccidae from Eastern Asia. *Bull. Ent. Res. 12:* 211-220.

FERRIS, G.F. (1936): Contribution to the knowledge of the Coccoidea (Homoptera). (Contribution No. 1). *Microentomology, 1:* 1-16.

FLETCHER, T.B. (1919): Annotated list of Indian Crop-pests. *Ent. Mtg., 3, Pusa, Rpt. Proc. 1:* 33-314 (286-304).

FLETCHER, T.B. (1921): Additions and corrections to the list of Indian crop-pests. *Ent. Mtg. 4, Pusa, Rpt. Proc.*, pp. 14-20 (18-20).

GANGULI, R.N. & GHOSE, M.R. (1964): Coccids of Tripura. *Indian Jour. Ent., 26:* 358-359.

GENNADIUS, P. (1895): Sur deux cochenilles du caroubier dans l'ile de chypre (Hem.). *Soc.. Ent. de France Ann. (Bul des Seances) 64:* cclxxvii.

GEOFFROY, E.L. (1762): Histoire abregee les insectes qui se trouvent aux environs de Paris, v. 1. pp. 498-513.

GHOSE, S.K. (1961): Studies on some coccids (Coccoidea : Hemiptera) of economic importance of West Bengal, India. *Indian Agr. 5(1):* 57-78.

GILL, R.J., NAKAHARA, S. & WILLIAMS, M.L. (1977): A review of the genus *Coccus* Linnaeus in America North of Panama (Homoptera : Coccoidea: Coccidae), State of California. Dept. Food & *Agriculture Div. Plant Industry-Laboratory Service*, No. 24: 1-44.

Green, E.E. (1886): Observations on the green scale bug in connection with the cultivation of coffee. *Enton. Pundaluoya*, 4p.

Green, E.E. (1896): Catalogue of Coccidae collected in Ceylon. *Indian Mus. Notes 4* (1896-1900): 2-10.

Green, E.E. (1900): Remarks on Indian scale insects (Coccidae), with descriptions of new species. pt. I. *Indian Mus. Notes 5:* 1-13.

Green, E.E. (1904): The Coccidae of Ceylon. pt. III. London Dulau. pp. 171-249.

Green, E.E. (1908): Remarks on Indian scale insects (Coccidae) part III with a catalogue of all species hitherto recorded from the Indian continent. *India Dept. Agr. Mem., Ent. Ser. 2:* 15-46.

Green, E.E. (1918): Some remarks on Mr Kunhi Kannan's paper, 'An instance of mutation'. *Ent. Soc. London, Trans. 1918:* 149-154.

Green, E.E. (1922): Supplementary notes on the Coccidae of Ceylon, part IV. *J. Bombay Nat. Hist. Soc. 28:* 1007-1037.

Green, E.E. (1937): An annotated list of the Coccidae of Ceylon, with emendations and addition to date. *Ceylon Jour. Sci., Sect. B., Zool. and Geol. Spolia Zeylanica 20:* 277-341.

Hodgson, C.J. (1967): Notes on Rhodesian Coccidae (Homoptera: Coccoidea) Part I. The genera *Coccus, Parasaissetia, Saissetia* and a new genus *Mashona. Arnoldia (Rhodesia) 3(5):* 1-22.

Kannan, K.K. (1918): An instance of mutation: *Coccus viridis*, Green, a mutant from *Pulvinaria psidii* Maskell. *Ent. Soc. London, Trans. 1918:* 130-148.

Kirkaldy, G.W. (1902): Hemiptera. *Fauna Hawaiiensis 3:* 93-174 (102-112).

Kuwana, I. (1902): Coccidae from the Galapagos Islands. *N.Y. Ent. Soc. Jour. 10:* 28-33.

Kuwana, I. (1909): Coccidae of Japan (IV). A list of Coccidae from the Bonin Islands (Ogasawarajima), Japan. *N.Y. Ent. Soc. Jour. 17:* 158-164.

Lindinger, L. (1928): Bericht Uber die Tatigkeit der abteilung fur pflanzenschutz. *A. Hamburg. Inst. f. Angew. Bot. Jahresber. 1924/26:* 94-110 (94-107).

Linnaeus, C. (1758): Insecta, Hemiptera. *Coccus. Systema Nat.* (Ed. 10) *1:* 455-457.

Mamet, R. (1936): New species of Coccidae (Hemipt., Homopt.) from Mauritius. *Roy. Ent. Soc., London, Proc. Ser.* B: *Taxonomy 5:* 90-96.

Maskell, W.M. (1890): Further notes on Coccidae, with descriptions of new species from Australia, Fiji and New Zealand. *New Zeal. Inst. Trans. and Proc. 22 (1889):* 133-156.

Maskell, W.M. (1897a): Further coccid notes: with descriptions of new species and discussions of points of interest. *New Zeal. Inst. Trans. and Proc. 29 (1896):* 293-331.

Maskell, W.M. (1897b): On a collection of Coccidae, principally from China and Japan. *Ent. Monthly Mag. 33:* 239-244.

Misra, C.S. (1924): A list of Coccidae in the Pusa collection. *Ent. Mtg. (Pusa,* 1923) *Proc. 5:* 345-351.

Morrison, H. (1921): Some nondiaspine Coccidae from the Malay Peninsula, with descriptions of apparently new species. *Philippine Jour. Sci. 18:* 637-677.

Newstead, R. (1892): On new or little known coccidae, chiefly English (No. 2). *Ent. Monthly Mag. 28:* 141-147.

Newstead, R. (1903): Monograph of the coccidae of the British Isles, v. 2 (1902): *London, Roy. Society*, 270 p.

Newstead, R. (1917): Observations on scale-insects (Coccidae) - III. *Bull. Ent. Res. 7:* 343-380.

Puttarudriah, M., & Channabasavanna, G.P. (1953): Occurrence of *Coccus viridis* (Green) and *Coccus viridis colemani* Kannan, in South India. *Indian Coffee 17:* 248-253.

Rao, V.P. & Kumar, H.K. (1952): Little known or hitherto unrecorded species of coccids from the Indian region. *Indian Jour. Ent. 14:* 1-10.

Sanders, J.G. (1909): Catalogue of recently described coccidae - II. *U.S. Dept. Agr. Bur. Ent. Tech. Ser. 16:* 33-60.

Signoret, V. (1873): Essai sur les cochenilles ou gallinsectes (Homoptera: Coccides). *Soc. Ent. de France Ann.* (Ser. 5). *3:* 395-400.

Takagi, S. (1975): Coccoidea collected by the Hokkaido University expedition to Nepal Himalayas, 1968 (Homoptera). *Insecta Matsumurana No. 6:* 1-33.

Takahashi, R. (1952): Some species of nondiaspine scale insects from the Malay Peninsula. *Insecta Matsumurana 18 (1/2):* 9-17.

Targioni-Tozzetti, A. (1891): Cocciniglie degli agrumi in italia specialmente in sicilia. Secndo le notizie raccolte, le osservazioni e le esperienze. *R. Staz. di Ent. Agri. di Firenze*. 32 p.

Varshney, R.K. (1985): A review of Indian Coccids (Homoptera, Coccoidea). *Oriental Insects 19:* 1-101.

Williams, M.L. & Kosztarab, M. (1972): Insects of Virginia no. 5 Morphology and systematics of the Coccidae of Virginia, with notes on their biology (Homoptera: Coccoidea). *Va Polytech. Inst. State Univ. Res. Div. Bull. 52:* 215 p.

Zimmerman, E.C. (1948): Insects of Hawaii, vol. 5. Homoptera: Sternorhyncha. Honolulu, Univ. of Hawaii Press. pp. 132-436.

STATUS OF THE BENGAL FLORICAN *HOUBAROPSIS BENGALENSIS* IN INDIA[1]

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(With ten text-figures)

The Bengal florican is perhaps the most endangered among the world's 22 species of bustards. It was once common in the *terai* of Uttar Pradesh, Bihar, the *duars* of Bengal and the Brahmaputra valley of Assam (Ali and Ripley 1969). Outside India, it was found in Nepal, Bangladesh and Kampuchea. It is possibly extinct in Bangladesh (Khan 1982) and there is no recent record from Kampuchea. In Nepal, it is found in some protected grasslands in Sukla Phanta, Royal Bardia, Chitwan and Kosi Barrage areas (Inskipp and Inskipp 1983, 1985). In India it survives in many disjunct pockets in Assam, West Bengal and Uttar Pradesh. It is doubtful whether any viable population is left in Bihar and, barring an exception, perhaps it is the same in West Bengal. Assam possibly has more than half of the worldés population of the Bengal florican, but even there they are restricted to isolated pockets of protected areas (Fig. 1).

The Bengal florican seems to have been totally eliminated from non-protected or inadequately protected areas in its former range. Indiscriminate conversion of grasslands into agricultural settlements and overgrazing has brought this magnificent bustard closer to extinction. This paper describes the current status of the Bengal florican in India. The paper is based on surveys done between 1985 and 1989 under the Endangered Species Project of the BNHS.

METHODOLOGY

Observations were made mainly during the early morning or late evening, when the floricans are most active. As our chief aim was to locate as many birds as possible, the potential grasslands were first intensively watched from a jeep or an elevated spot. Later, attempts were made to flush the floricans, either by 3-4 people walking equidistant to each other or by scanning grasslands from elephant back. The number of floricans seen, their sexes, activity, time, weather, condition of the habitat, and time spent in each area were noted in a proforma.

Florican posters were distributed among the forest officials, guards, herdsmen and villagers, and inquiries were made from old hunters, naturalists and local elders in each area. Extensive notes on other wildlife seen, general condition of the forest and disturbances to the grasslands were maintained.

Important florican areas were visited during the peak breeding season, when territorial males were easily seen during their aerial display. As has been proved by our earlier studies, bustards are very territorial during the breeding season (see Ali and Rahmani 1982-84, Sankaran & Rahmani 1986, Manakadan and Rahmani 1986). Thus the location of a territory i.e. display site of a male, is the identification of an individual male florican. As hen floricans are not easy to locate and appear to wander between territories, generally only the males of an area were sighted. Although we saw fewer hens than cocks, the population estimate is based on the assumption that the sex ratio is equal in this species.

Some of the sanctuaries mentioned here are either new or have not been described in the scientific literature; therefore, whatever important data we could collect about such areas are included.

HABITAT

According to Ali and Ripley (1969), the Ben

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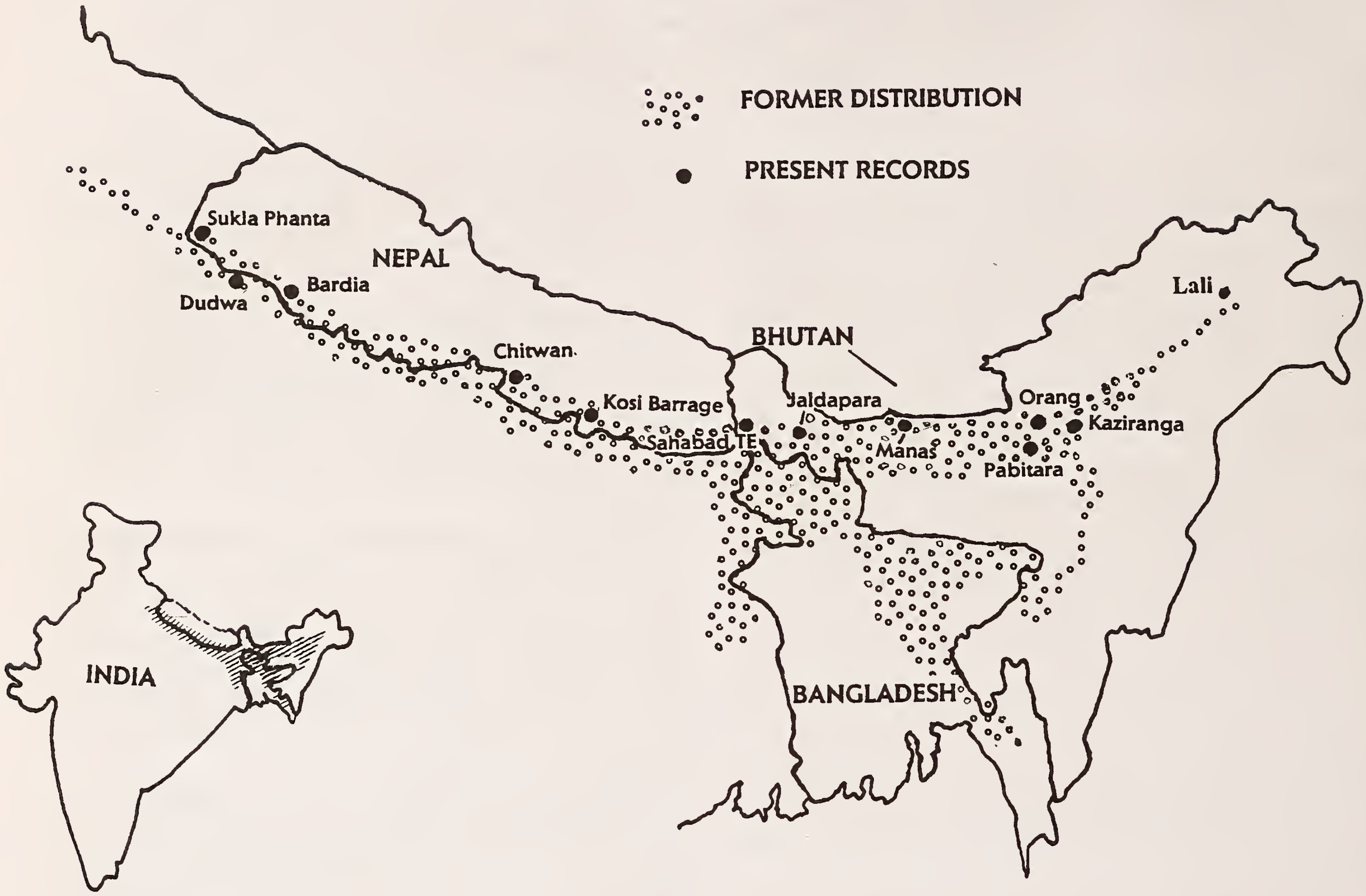

Fig. 1 Former distribution and present records of the Bengal florican in the Indian subcontinent.

gal florican lives in "tall grassland interspersed with scattered scrub and bushes, especially where grazed down to about half metre height or regenerating after the seasonal fire". Inskipp and Inskipp (1983) have also found them "almost entirely in pure grassland habitat". The dominant grasses in most florican habitats are *Imperata cylindrica*, *Narenga porphyrocoma*, *Setaria pumilla* and *Saccharum* and *Themeda* species (Table 1). Inskipp and Inskipp (1983) also found that *Imperata cylindrica* is the dominant grass species in 16 out of 20 sites studied by them. *Bombax ceiba* among the trees, *Cyperus* spp. among sedges, and *Grewia sapida* and *Sonchus* spp. among shrubs are dominant over other plants in most florican areas, especially in Assam. Omission of a plant species in Table 1 does not necessarily mean the absence of that plant in a given florican area; because we visited many florican areas only briefly an in-depth analysis of plant species composition could not be made.

Survey Results

Assam

Till the early decades of this century, most of the alluvial grassy plains in the Brahmaputra valley in Assam, west of the present Sibsagar district up to the Himalayan foothills in the north, were good florican country. North of the Brahmaputra, the Biswanath plains, most of Darrang district and all the grasslands in the Assam *duars* including the present Kamrup, Nalbari, Barpeta and Kokraj-

TABLE 1
COMMON PLANT SPECIES OF SOME FLORICAN HABITATS

Plant species	Manas	Orang	Pabitora	Kaziranga	Jaldapara	Dudwa
Grasses						
Imperata cylindrica	+	+	+	+	+	+
Narenga porphyrocoma	+	+	+	+	+	+
Saccharum spontaneum	+	+	+	+	+	+
Vetiveria zizanoides	+	+	+	+	+	+
Setaria spp.	+	+	+	+	+	+
Desmostachya bipinnata	+	+	+	+	+	+
Themeda spp.	+	+	+	+	+	+
Cymbopogon spp.	+	+		+	+	+
Arundinella spp.	+	+				
Phragmites karka	+	+	+	+	+	+
Erianthus ravennae	+	+	+	+	+	
Arundo donax	+	+	+	+	+	+
Herbs and shrubs						
Cyperus spp.	+	+	+	+	+	+
Fimbristylis spp.	+	+	+	+	+	+
Grewia sapida	+	+	+	+	+	+
Sonchus spp.	+	+				
Leea crispa	+	+		+	+	
Blumea spp.	+	+				
Vernonia cinerea	+	+	+	+	+	+
Osbekia rostrata	+	+				
Crotolaria spp.	+	+		+	+	+
Oxalis corniculata	+	+			+	+
Ageratum conyzoides	+	+		+	+	
Desmodium spp.	+		+	+		
Pygmaeopremnaherbacea	+					
Trees						
Bombax ceiba	+	+	+	+	+	+
Dillenia pentagyna	+	+		+	+	
Gmelina arborea	+	+	+	+	+	
Embellica myrebelon	+	+		+	+	
Oroxylum indicum	+	+		+	+	
Careya arborea	+	+				
Shorea robusta	+	+		+	+	+
Acacia catechu	+	+		+	+	+
Dalbergia sissoo	+	+			+	+
Lagerstroemia parviflora	+	+	+	+	+	+
Terminalia spp.	+	+	+	+	+	+

har districts had some of the best florican areas in the country. In the east, the Bengal florican was seen up to the foothills in Sadiya plains. It was less commonly found south of Brahmaputra river, from Goalpara to Dibrugarh, and was extremely rare anywhere south of Nagaon district. Even till the middle of this century the florican was not uncommon in most of these areas.

Assam possibly has more than a third of the worldés population of the Bengal florican. However, their viable populations are restricted only to the three better protected areas in the state —Manas, Orang and Kaziranga (Fig. 2).

The largest numbers survive in Manas Tiger

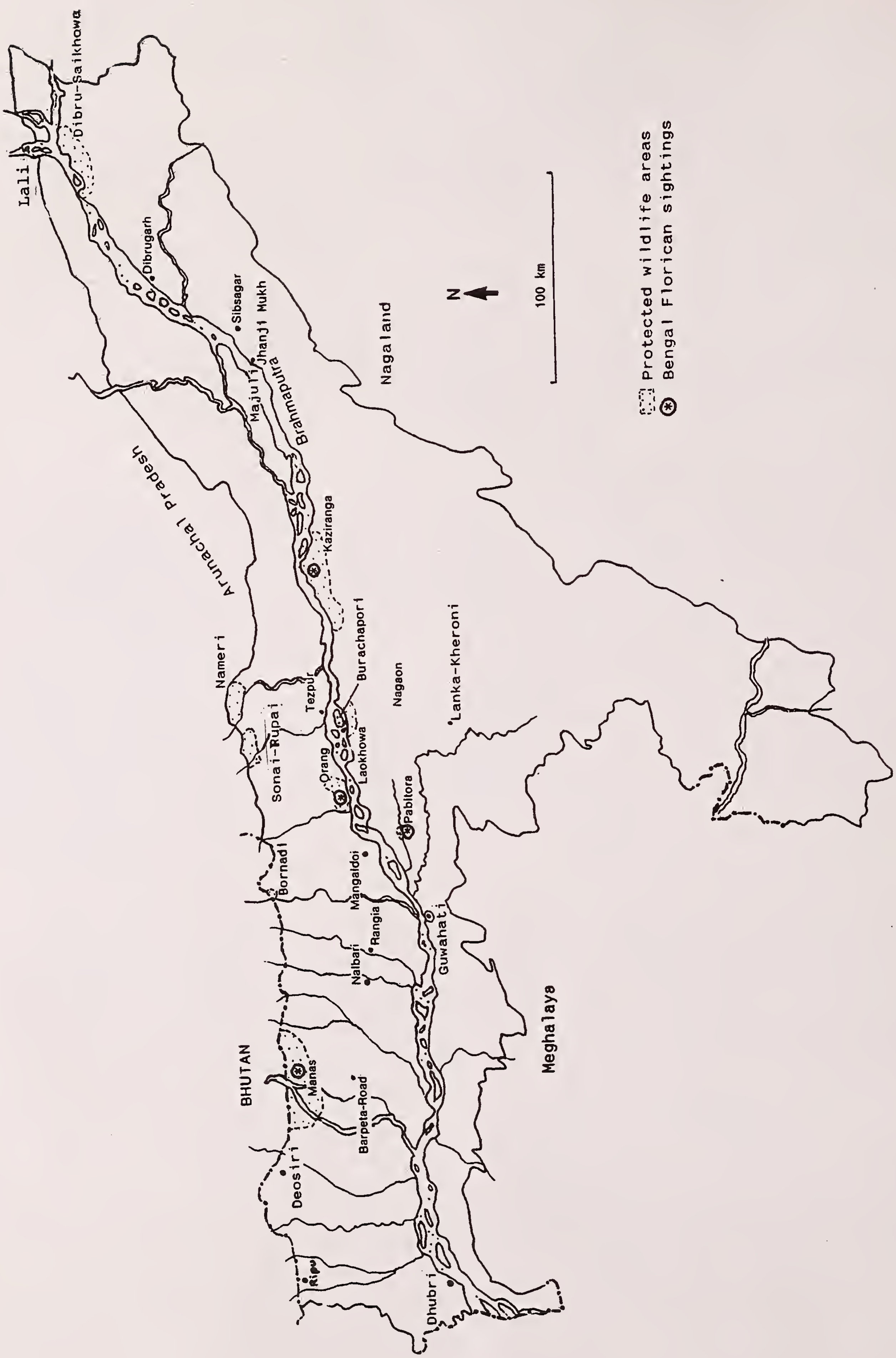

Fig. 2. Major sites in Assam surveyed for Bengal florican between 1985 and 1989.

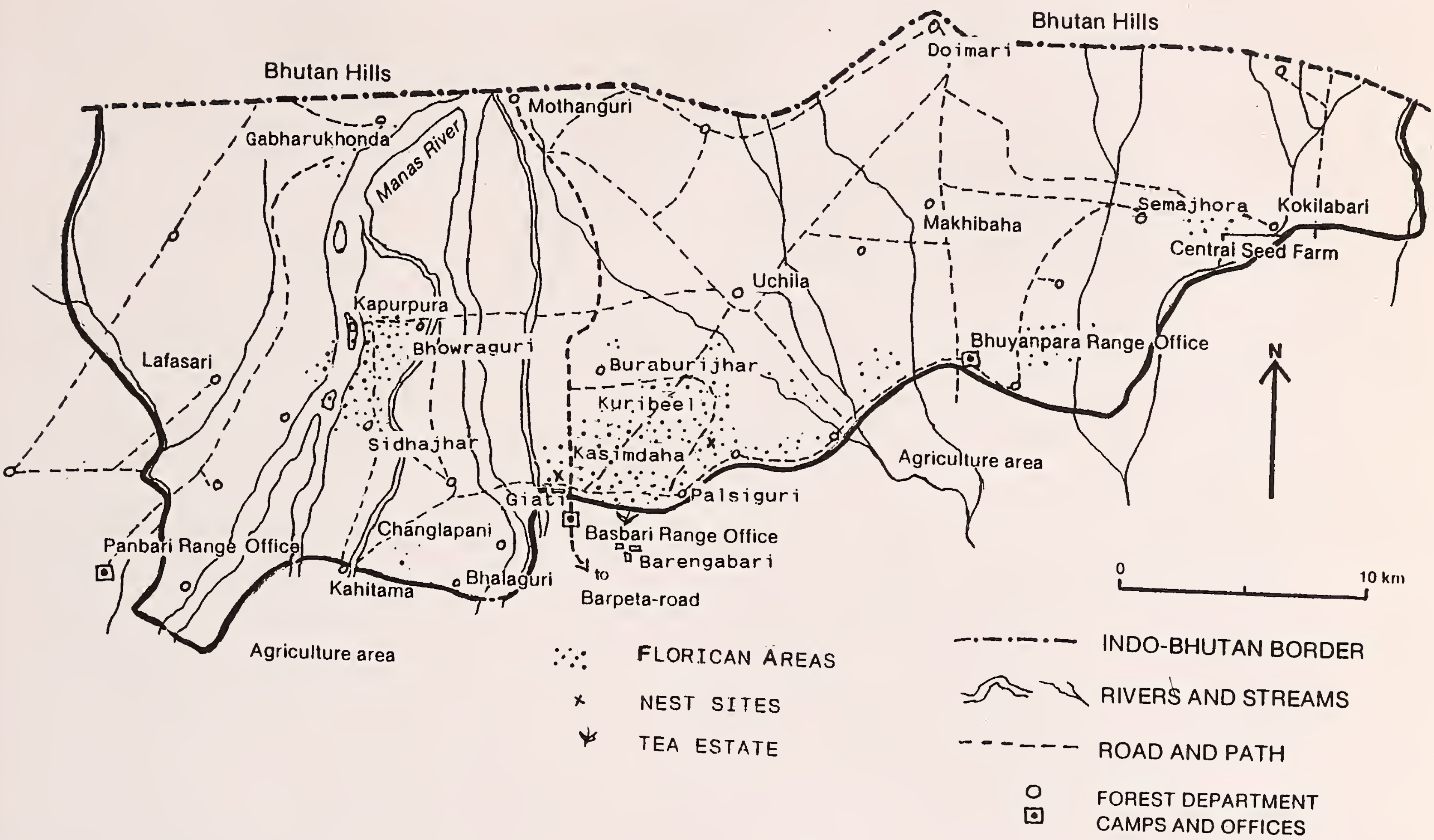

Fig. 3. Manas Wildlife Sanctuary

Reserve while Orang Wildlife Sanctuary is another very good habitat for the bird. Although Kaziranga National Park has some good grasslands, most of it is not suitable for florican, in spite of the Park being about six times as large as Orang. The number of floricans inhabiting the two places may be more or less the same. Pabitora Wildlife Sanctuary is the only other place in Assam where we saw the floricans in 1988, but none were seen in 1989 in this tiny sanctuary. The florican may still exist in very small numbers in a few more pockets but these populations are highly vulnerable.

MANAS WILDLIFE SANCTUARY

District: Barpeta, Kokrajhar, Nalbari.
Coordinates: 90° 45′ to 91° 25° and 26° 40′ to 26° 50′ N
Size: 391 sq.km (Manas WLS is the core **area** for the 2837 sq. km Manas Tiger Reserve)
Forest Types: Moist mixed deciduous and tropical semi-evergreen forests; alluvial grasslands.
Area under grassland: About 60%
Study period: 3 to 7 May 1985: 3 to 10 Jan. and 17 Mar. to 4 June 1986: 18 Feb. to 2 Apr., 20 Apr. to 13 July 1987: 26 Jan. to 20 Apr., 2 May to 26 June, 4 to 12 July, 21 July to 5 Aug., 22 Aug. to 8 Sept., 12 to 31 Dec., 1988: 1 Jan. to 23 Feb., 10 to 19 Mar., 2 to 16 Apr., 10 to 30 May 1989.
Grasslands surveyed: Basbari Range: Kasimdaha and Mahout Camp fields near Giati and Barengabari, Kuribeel, Palsiguri, Uchila, Buraburijhar, Latajhar, Bhowraguri, Sidhajhar, Kapurpura, Bhalaguri and Kahitama. Bhuyanpara Range: Katajhar, Bhatgeli, Dighaltari, Semajhora and Kokilabari. Panbari (Fig. 3).

Habitat: The florican habitat in Manas consists of extensive open (almost treeless) grasslands with comparatively shorter varieties of grasses and shrubs. These grasses rarely grow beyond 200 cm in height whereas in some other areas the grass

TABLE 2
IDENTIFIED TERRITORIES OF MALE BENGAL FLORICANS AT MANAS WLS

Area	Location	Total no. of sites used as territories from 1987 to 1989	No. of territories in 1988	No. of territories in 1989
1. Kasimdaha	Between Basbari Range office, Pohu Field Saltlick and Pygmy Hog enclosure, west of main road	7	6	7
2. Mahout Camp Field	Area west of main road, north of Basbari (Giati) Mahout Camp	4	3	3
3. Palsiguri	West-northwest of Palsiguri camp near Barengabari, east of Basbari Uchila road	3	3	1
4. Uchila, Bongali Hathdhowa	Bhatgeli camps	1	1	?
5. Kuribeel	On both sides of Basbari-Uchila road, in area around watch tower	6	2	6
6. Buraburijhar	In the manually cleared saltlick patch	1	1	1
7. Sidhajhar and Kapurpura	a) Between Sidhajhar camp and Kapurpura camp along Manas river	6	6	5
	b) Sout-heast of the Kapurpura Bhowraguri road	2	2	1
	Total	30	24	24

may grow up to 500 cm or more. The grasslands are maintained by annual burning in winter months and to some extent by inundation during the monsoon. Isolated or small clumps of trees, mostly silk cotton *Bombax ceiba*, are scattered sparsely all over the grassland. Regulated burning is carried out to prevent spread of these trees and also to clear the area of the previous yearés dead stems and leaves. Grass harvesting is minimal.

Results: Between 1986 and 1989, at least 30 sites were identified as being used by male Bengal florican as breeding territories in the accessible study sites of the Basbari Range of Manas WLS (Table 2). All good florican habitat had short, moderately dense grass which was maintained by either controlled ‘weté burning, grazing by wild herbivores or limited thatch collection without prolonged disturbance.

Although site fidelity is often shown by male floricans, they may not establish or successfully maintain territories in sites rendered unsuitable. Causes for alteration of the habitat are usually improper or excessive burning, cutting or grazing of grass or even increased cattle and human disturbances. In these areas 24 territories were identified in 1988 and 1989, some of which were new sites or were being used after one season. All 30 territories were not counted in a single breeding season.

Additionally, a few floricans whose territories were not located and 2 to 3 immature males were seen in Basbari. Females were seen in all these areas and it is certain that their sex ratio is equal. It can therefore be estimated that at least 60 Bengal floricans are present in the Basbari range of the sanctuary.

Bengal floricans were also seen in the Semajhora-Kokilabari areas of the Bhuyanpara range in the sanctuary. Some other areas like Dighaltari and Digjari in this range appeared good for floricans. Floricans were also reported from Gabharukhonda and some other grasslands of

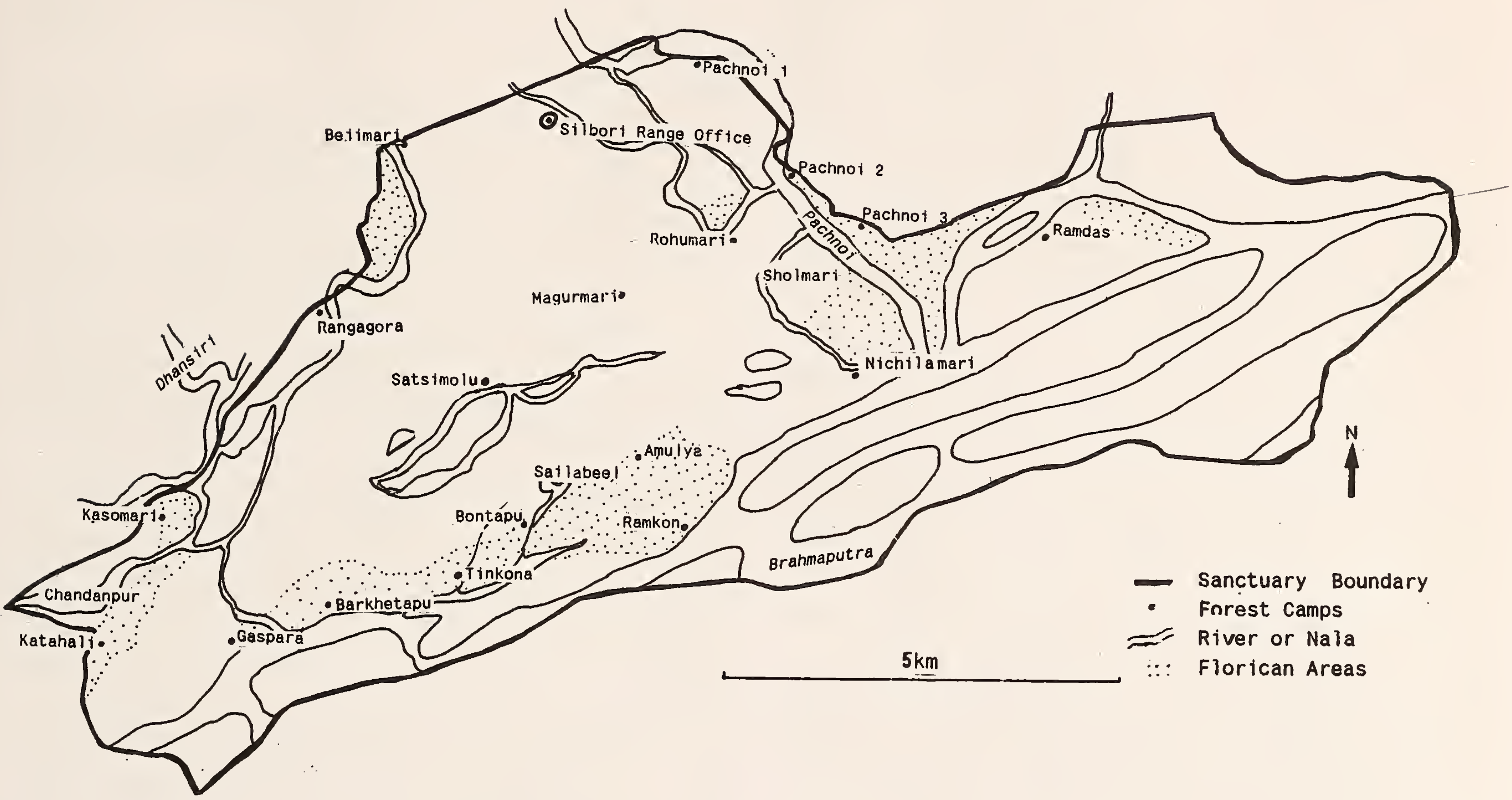

Fig. 4 Orang Wildlife Sanctuary.

Panbari range. The areas under both these ranges are disturbed due to the ongoing tribal agitation and status of florican there is uncertain.

A rough estimate would put the total florican numbers in the Wildlife Sanctuary at least 80 birds. It appears that floricans do not exist in areas outside the protected areas of the Sanctuary.

Orang Wildlife Sanctuary

Location: 26° 35′ to 26° 40′N and 92°15′ to 92° 25′ Darrang and Sonitpur districts.
Size: 70 sq. km.
Forest Types: Alluvial grassland, planted deciduous forest and swampy area.
Dates of visits: 7 to 9 May 1985: 22 to 23 April, 1, 2 and 19 July. 1988: 24 to 26 March and 4 to 7 May 1989.
Grasslands surveyed: Satsimolu, Amulya, Ramkon, Sailabeel, Bontapu, Tinkona, Kasomari, Gaspara, Katahali, Chandanpur, Barkhetapu, Rangagora, Bejimari, Magurmari, Rohumari, Sholmari, Nichilamari, Pachnoi and Ramdas.

Habitat: Orang (Fig. 4) is situated on the northern bank of the alluvial flood plains of the Brahmaputra. The Dhansiri river, a tributary of the Brahmaputra, flows along its western boundary while another tributary, the Pachnoi, passes through its eastern part. Two distinct alluvial terraces, the lower Orang of more recent origin along the Brahmaputra and the older upper Orang to its north, are separated by a high bank traversing the sanctuary from east to west.

Orang was earlier a pure alluvial grassland. In 1915 it was declared a game reserve. In 1932, plantation of fast growing local species such as *Acanthocephalus kadamba*, *Albizzia procera*, *Lagerstroemia flosreginae* was started, and some parts of the reserve were denotified to settle farmers from erstwhile Bengal under the grow-more-food programme. Intensive plantation was started in 1962. Along with the earlier planted local species, *Eucalyptus*, *Dalbergia sissoo*, *Acacia catechu*, *Tectona grandis*, *Artocarpus chalasha*, *Terminalia* spp., *Gmelina arborea* and *Bombax ceiba* were planted. In 1969, some

Professional Grazing Reserve (PGR) areas east of the river Pachnoi were included in the Game Reserve. Orang was managed under Project Tiger as an auxiliary reserve area from 1972 to September 1985, when it was upgraded from a game reserve to a wildlife sanctuary. Mainly established to save the highly endangered great Indian one-horned rhinoceros *Rhinoceros unicornis*, numbering about 65, only some of its grasslands are suitable for the florican.

Results: In May 1985, seven Bengal floricans were seen in a two day survey. In 1988, initial survey was carried out by five people in two groups on 22 and 23 April and altogether 13 floricans were seen, most of them in Lower Orang in the southern and south-western parts of the sanctuary. In 1989, 10 males and three females were sighted between 24 and 26 March, and additionally, five more floricans were reported from different areas by Forest Department staff. We saw nine floricans between 4 and 7 May 1989.

The extensive thatch fields around Amulya, Ramkon and Sailabeel harboured at least six males. A female with two chicks was seen here on 1 July 1988. Floricans were also seen in Katahalli, Kasomari, Barkhetapu, Tinkona, and Bontapu areas of lower Orang and Rohumari in upper Orang. The recent inclusions to the sanctuary with vast stretches of short thatch grass in Nichilamari and Pachnoi areas are good florican habitats. Six floricans in May 1985 and four in May 1989 were seen there.

Floricans were also seen in the former PGR areas on the eastern side of Pachnoi river. The Range Forest Officer, B.N. Talukdar, reported the florican from Ramdas *chapori* of Brahmaputra but this island could not be surveyed properly by us. The grasslands along Rangagora Pathar on the western boundary which is planned to be incorporated in the sanctuary are also suitable, and a male florican was seen near Bejimari in March 1989.

After Manas, Orang is the most important florican habitat in Assam, and we estimate that at least 30-40 birds may be present in this small sanctuary.

Kaziranga National Park

Location: 26° 30′ to 26°45′ N, 93° 05′ to 93° 40° E. Golaghat and Nagaon districts.
Size: About 400 sq. km.
Forest Type: Alluvial flood plains of the Brahmaputra river, eastern alluvial grasslands, low alluvial savanna woodlands, serial stages of moist mixed deciduous forests, tropical evergreen forests and waterbodies.
Dates of visits: 11-12 May. 1985: 26-28 April and 15-16 August. 1988: 2-7 March and 28-29 April 1989.
Grasslands surveyed: Mihimukh, Mihibeel, Kathpora, Arimora, Borbeel, Merbeel, Methunmari, Garematikhawa, Naste, Debeswary, Kartika, Hilekhunda, Soisala, Barnalani, Defolumukh, Bhawani, Baguri Borbeel, Dongabeel (Fig. 5).

Habitat: Famous for the one-horned rhinoceros, Kaziranga lies in the alluvial flood plains south of river Brahmaputra and extends to the foot of the Mikir hills. The total area of the park fluctuates around 400 sq. km due to the vagaries of the Brahmaputra. About 52% of the Park is grassland, about 6% wetlands and the rest is forested (Kushwaha and Madhavan Unni 1986). Most of the grasslands, however, consist of tall 'elephanté grass unsuitable for floricans.

Results: Three male floricans were seen at Mihimukh, Arimora and Methunmari areas of Kaziranga during our visit in 1985, when many other areas of the Park had become inaccessible due to floods. In 1988 too, we could not visit many good florican areas for the same reason. The only floricans seen by us were two males in the Mihimukh grazing ground near the entrance of the park. A hen florican was seen in the same area by the mahouts of the Forest Department, and in 1987 a nest was found by one of them. A male florican has been seen near Mihimukh for the last 13 years (R.N. Sonowal, pers. comm.).

The park was surveyed properly in the first week of March 1989 when almost all florican areas suggested by park authorities and a few other areas including the islands in the Brahmaputra were visited. In spite of the wide ranging survey we could spot only five male floricans at Mihimukh, Methunmari areas and Naste and Bhawani *chapories* (islands). Another island, Boralimora, which harboured floricans got washed away by the severe floods in 1988 (R.N.

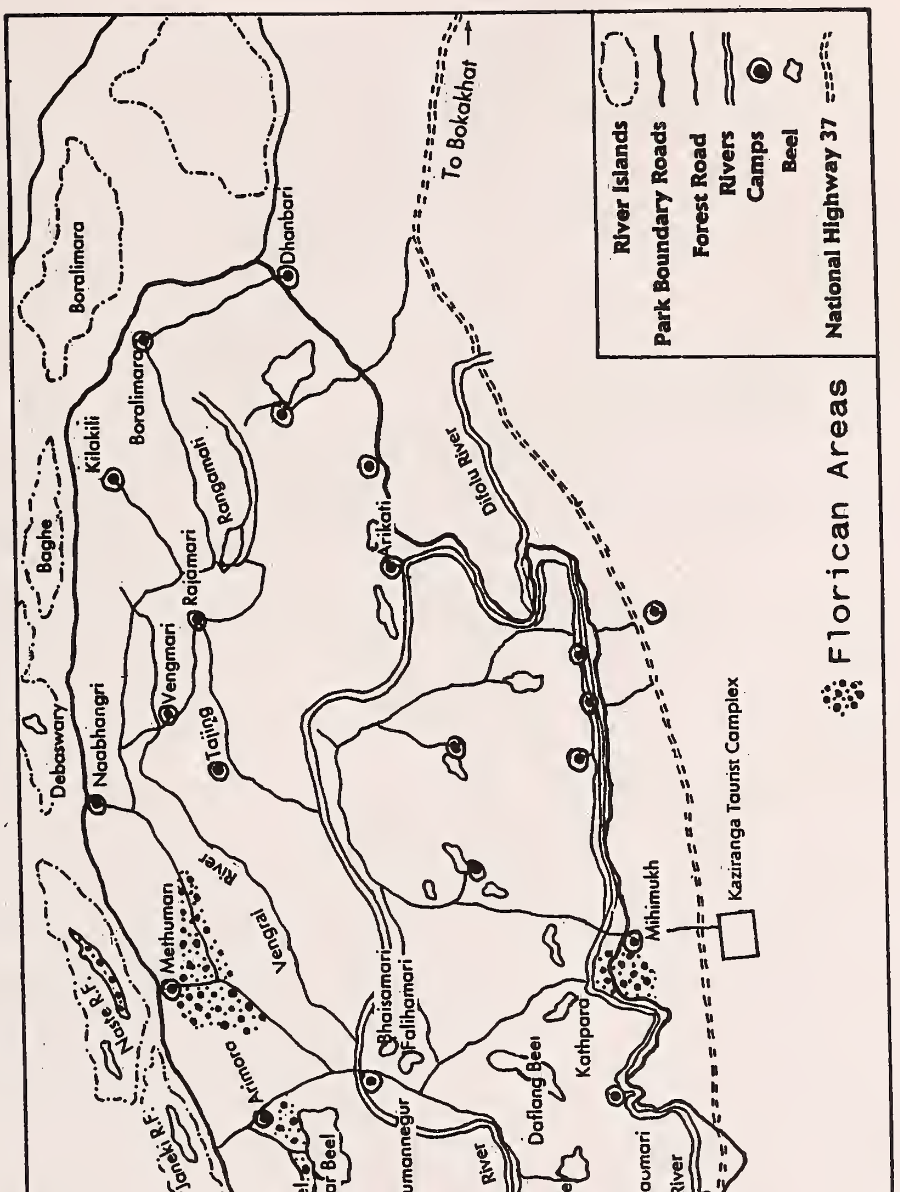

Fig. 5. Kaziranga National Park.

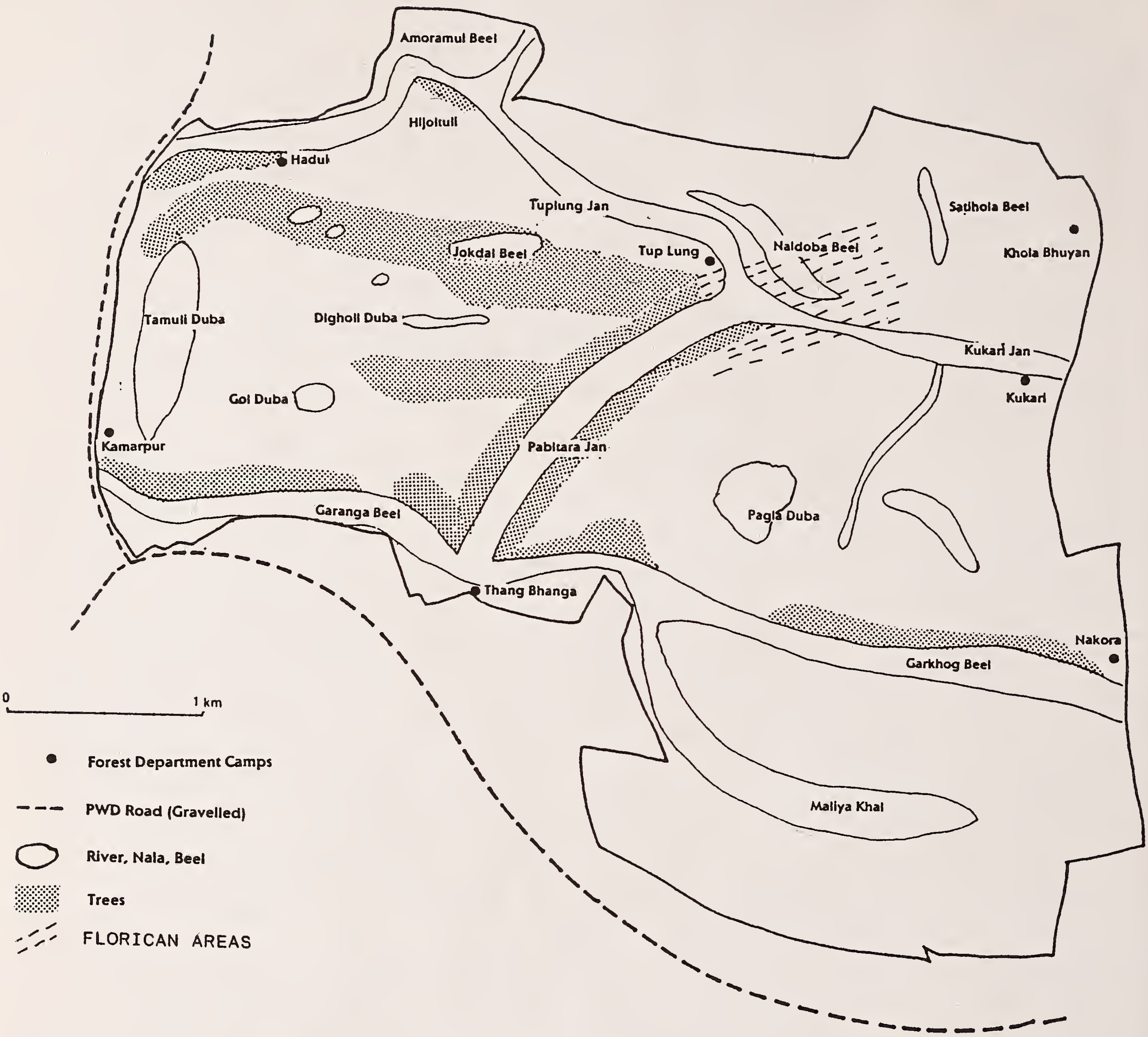

Fig. 6. The 16 sq.km area presently under Pabitora Wildlife Sanctuary where Bengal floricans were sighted for the first time during this survey.

Sonowal, pers. comm.)

In fact the changing vegetation pattern of the park due to recurring floods and prolonged water-logging may be one of major reasons for disappearance of florican habitats in Kaziranga, as many thatch areas are transforming into either tall grass or sandy areas. In 1988, 15 floricans were seen during the breeding season in Arimora, Hilekhunda, Methunmari and Merbeel areas and on 10 April 1988, a nest with two eggs was found among short grass at Methunmari (D. Boro, pers. comm.). In 1989, we found that Hilekhunda and Merbeel do not have any good florican areas left. Forest Department staff confirmed that taller grass have appeared in the places where floricans used to be seen earlier. Areas around Methunmari

including Naste *chapori* are still the best florican habitats of the park. Some of the islands such as Debeswary and Lumasala were either very sandy or had vegetation not suitable for florican. Some areas in the western most part of the park are also good and two male floricans were seen around Laharni in March 1989 (Parag Muley, pers. comm.). Altogether, there could be 25-30 floricans in Kaziranga.

Pabitora Wildlife Sanctuary

Location: 26°15'N & 92° E. Nagaon district.
Size: 16 sq. km.
Forest Types: Eastern alluvial grassland and flood plains.
Dates of visits: 15-16 May 1985. 30 April and 20 August 1988. 26-27 Feb., 21-22 March, 2-3 May 1989
Grasslands surveyed: Tuplung, Kukari and surroundings (Fig 6).

Habitat: Pabitora (Fig. 6) is more or less a grassland sanctuary, except for about 1 sq. km of forest and some waterbodies. The grassland is traversed by seasonal streams. Crop fields are present all around this tiny (16 sq. km) reserve. There are nearly 65 rhinoceros in the reserve, making it the most densely populated rhino area in India.

It was declared a wildlife sanctuary in 1987 and its area has provisionally been increased to 39 sq. km incorporating Raja Mayang Hill Reserve Forest and some other surrounding areas, much of which are under illegal occupation and cultivation.

Results: During our 1985 survey, we could not see any florican although we were told of occasional sightings in Pabitora. However, in 1988 we located three males and one female florican in Tuplung-Kukari areas. Two of these were territorial males with their territories within the cattle grazing zone. We were also told that two floricans were sold in the local market in April 1987. Unless adequate protection is given, the future of the florican in Pabitora does not appear very encouraging.

We saw no floricans during our three visits in 1989 and the habitat appeared a little degraded. We were told by the authorities that severe floods in 1988 had forced the destitute villagers to use the grasslands for thatch collection and cattle grazing on a much larger scale than in earlier years.

Barnadi Wildlife Sanctuary

Location: 26°50′ N, 91°55′ E. Darrang district.
Size: 26 sq. km.
Forest Types: High alluvial terrace in sub-Himalayan zone, highland savanna, eastern moist mixed deciduous forest and tropical semi-evergreen forests.
Dates of visits: 24 April and 29-30 June 1988.
Grasslands surveyed: Deosunga river bed and banks, and some former grasslands.

Habitat: Barnadi is situated at the foothills of the Bhutan Himalayas in Darrang district. In the west and south it is mostly surrounded by tea estates and in the east by agricultural fields for about 10 km, after which the Nonai Reserve Forests starts. On the northern boundary is Bhutan and on that side also there is a contiguous reserve forest.

Although about 60% of Barnadi sanctuary is reported to be grassland, most of it is now grassy woodland. Plantations of *Tectona grandis*, *Careya arborea*, *Artocarpus chaplasha*, *Dillenia* and *Anthocephalus* have destroyed the open grassland. The only open grassland in the sanctuary is along river Deosunga which is about 200 m at its broadest.

Barnadi forest was declared a wildlife sanctuary in 1981 mainly to protect the highly endangered pygmy hog *Sus salvinus* and hispid hare *Caprolagus hispidus*. Since these are mammals of open grassland it is puzzling why the tree plantations were continued even after 1981.

Results: The sanctuary was surveyed initially on 24 April and again on 29 June 1988. Many areas including Deosunga river bed were searched for floricans. During both visits, the river had very little water and the grassland appeared ideal for floricans. Although we could not see any floricans, we got reliable information from the forest guards that this bird occurs in Barnadi. A farmer from Rajagarh village which is close to the range office reported seeing a male and a female in a paddy field on 29 May. Two Forest Department employees saw solitary males in Nalanadi areas of the sanctuary in May (flying over) and in

mid-June. The Nalanadi area in the south-eastern corner of the sanctuary did not appear suitable and the floricans sighted there by the forest guard may have been temporary visitors.

At the time of writing the sanctuary was reported to be seriously disturbed by agitating Bodo tribals. Reports of burning of forest camps and subsequent desertion by protection staff have been received from there. We could not visit the sanctuary in 1989.

Sonai Rupai Reserve Forest (Proposed Wildlife Sanctuary)

Location: 26°55′N, 92°30′ E. Sonitpur district.
Forest types: Alluvial terrace in the eastern Himalayan foothills, tropical semi-evergreen moist deciduous forests and large open grassland patches in the plains.
Size: 175 sq. km.
Date of visit: 25 April 1988.
Grasslands surveyed: Gelgeli.

Habitat: The Sonai Rupai Reserve Forest contains tropical forests of *bhabar* type. Its northern boundary is contiguous with the excellent forest of Arunachal Pradesh. Plans are underway to declare it as a wildlife sanctuary. Presently, the forest is disturbed by human activities like hunting by tribals and army personnel and collection of minor forest products. The army also wants to convert some of the open areas into a firing range.
Results: Nearly 200 ha in extent, the Gelgeli grassland in Sonai Rupai is one of the best grasslands of its kind and quite suitable for the floricans. The thatch grass was short and the vegetation compared well with other ideal florican habitats which we have seen earlier in Manas, Orang and Kaziranga. However, an extensive search did not result in any florican sighting. Inadequate protection and disturbance seem to be the reason for the scarcity of wildlife in this beautiful reserve.

Nameri Wildlife Sanctuary

Location: 27° N, 92°50′ E. Sonitpur district.
Size: 138 sq. km.
Forest Type: Alluvial terrace in the eastern Himalayan foothills, tropical semi-evergreen moist deciduous forest with narrow strips of open grasslands along some rivers.
Dates of visit: 27-28 March 1989
Grasslands surveyed: Along Jia Bharali river including the islands near the place where its tributaries Upper Dekrai and Nameri meet into it.

Habitat: The habitat is similar to that of Sonai Rupai, with its excellent forests contiguous with those of Pakui WLS of Arunachal Pradesh. Open grasslands are restricted to the banks and *chapories* of the shallow, fast flowing Jia Bharali river.
Results: The surveyed grasslands, although not extensive, are suitable for floricans and it is possible for the bird to inhabit some of these areas. Some areas appeared overgrazed by cattle but relatively the sanctuary is much less disturbed than Sonai Rupai. We did not see floricans nor did the Forest Department staff report any. However, as effective protection is being provided only for the last 2-3 years, it is possible that the florican may appear here in due course.

Laokhowa Wildlife Sanctuary

Location: 26°30′ N, 92°40′ E. Nagaon district.
Size: 70 sq. km.
Forest Types: Alluvial flood plains of the Brahmaputra river. Seral stages of moist mixed deciduous forests, tropical semi-evergreen forests and aquatic areas.
Dates of visit: 13 May 1985, 29 April 1988, 28 Feb.- 1 March 1989.
Grasslands surveyed: Singhimari – 14th Mile, Sonaikusi, Borunguri, Laokhowa – Kathpora, Balukjan, Tekhala, Lathimari, Goldubi – Molamari, Rohumari, Kathalguri.

Habitat: Similar to Kaziranga in terrain and situated further downstream on the southern bank of the Brahmaputra, roughly 35% of Laokhowa is grassland, 30% under waterbodies and the remaining area under natural forest or plantation of *Bombax ceiba, Dalbergia sissoo* and *Albizzia procera.* Marasuthi, a tributary of the Brahmaputra flows along the north-western part of the sanctuary.

There are eight forest villages — seven inside the sanctuary, and one just at the boundary, and several tribal settlements. In total, 10000-15000 people belonging to Bodo and Lalung tribes stay inside the sanctuary. Moreover, immigrant agriculturists from East Pakis-

tan/Bangladesh have settled all around the sanctuary.

Although Laokhowa was declared as a wildlife sanctuary in 1971 it was brought under Western Assam Wildlife Division only in June 1987. Commercial fishing and grass cutting rights have been suspended, but the sanctuary still provides fish, thatch grass, fodder and fuel to atleast 15000 people, most of them from the eight tribal villages within the sanctuary. Additionally, hundreds of people and thousands of cattle from villages and buffaloes from *khutis* (camps) still come there every day.

Results: During our 1985 survey we found that Laokhowa was highly disturbed and there was hardly any chance of the florican surviving there. However, apparently the conditions had improved marginally after it was brought under the wildlife division and a male florican, probably a temporary visitor, was seen in February 1988 by Ishfaq Ahmed, ACF. We did not see any. There is no doubt that given adequate protection to the habitat, the florican will breed in the grasslands of the sanctuary, but a continuous monitoring of the habitat is necessary, especially when there is so much human pressure on this small sanctuary.

Our last survey showed that the grasslands of the sanctuary are still too disturbed for a shy bird like the Bengal florican. Laokhowa had over 60 rhinoceros before they were killed indiscriminately in the 1970s and finally eradicated during the political upheaval of the Assam agitation in the early '80s. Even now, the one or two rhinos arriving occasionally from other areas are not spared. The grasslands are presently not safe enough for the florican.

Burachapori & Kochmara Reserve forests
(Proposed Burachapori Wildlife Sanctuary)

Location: 26°35′ N, 92°30′ to 92°45′ E. Sonitpur district.
Size: 65.5 sq. km (Burachapori 44 sq. km, Kochmara 21.5 sq. km)
Forest type: Alluvial flood plains of the river Brahmaputra.
Dates of visit: 1, 28 and 29 March 1989.
Grasslands surveyed: Dhania, Khulomukoli, Jhowbon, Basabari, Siali, Senimari and Kochmara.

Habitat: Burachapori and Kochmara are two islands along the southern bank of the Brahmaputra close to Laokhowa WLS. A narrow stream, the Laokhowa Suti, separates Burachapori from a part of Laokhowa. A few decades ago almost 90% of these islands were grass covered. Overgrazing by domestic buffaloes and cattle, human encroachment, tree plantation and lack of proper protection and management has substantially depleted the extensive grasslands of these fertile but flood prone islands. Still, about half the area of these islands is under grass. Some of the areas along the river shore are sandy and covered with *Tamarix*.

Results: Most of Kochmara and a part of Burachapori are encroached by immigrant agriculturists from erstwhile East Pakistan/Bangladesh. Their main crop is paddy. Even now grasslands are being converted into crop fields and we saw new areas being tilled by the encroachers.

Additionally, about 500 cattle and buffalo *khutis* , out of which over 350 are in Burachapori, are located within the proposed sanctuary. More than 20,000 cattle and buffaloes spread out in these islands and many cross over to Laokhowa WLS from these *khutis*.

Most of the existing grasslands are degraded or disturbed. Over 600 ha of open grasslands in Burachapori has been successfully planted with *Dalbergia sissoo*, making those areas unsuitable for floricans. Kochmara too has plantations but they are not successful and some Forest Department staff reported sighting a florican-like bird in the grassy patches inside plantation enclosures.

Although we did not see floricans, it is possible that a few still exist there as the area was perhaps one of the best florican habitats in Assam. However, unless the human pressure is reduced and proper protection is provided, there is no hope for the proposed wildlife sanctuary. The rhinoceros was exterminated from Laokhowa–Burachapori areas in the early the 1980s and since 1988 four rhinos arrived here, probably from Kaziranga or Orang. Out of these three have been killed and the fourth injured by poachers. There is therefore serious concern about the viability of these sanctuaries.

Majuli Island

Location: 26°50′ to 27° N, 93°50′ to 94°30′ E. Jorhat district.
Forest type: Alluvial flood plains of Brahmaputra.
Dates of visit: 24-26 April 1989.

Habitat: The worldés largest river island, Majuli, is mainly under human habitation. The main stream of the Brahmaputra flows on its southern side; the vegetation of the island is similar to that of the northern bank of the river. Some areas on the island not connected to its inhabited parts appear as grasslands, while a few small islands adjacent to the main island are grass covered. The whole area is badly affected by floods in the rainy season.

Results: Being closer to the northern bank of the Brahmaputra, Majuli must have had Bengal florican habitats before cultivators took over. Floricans are still present on similar but uninhabited islands near Kaziranga, only about 40 km downstream. The Bishwanath plains on the north-western side of Majuli was once a good florican area. The open grasslands of Majuli were the first to be converted into cultivated fields, and now the remaining patches of grasslands are disturbed. The inhabitants of the island did not recognise the bird, except for a retired Forest Department employee from Kaziranga, who has been staying there for the last 12 years and reported sighting a male florican in 1987.

Other Areas in Assam

In addition to the places mentioned so far several other areas in Assam were surveyed for floricans and their habitat. These included areas from where Bengal floricans were reported in good numbers even about 25 to 30 years ago. Deosiri (26° 45′ N, 90° 50′ E) and Ripu Reserve (approx. 26° 40′ N, 90°E) in Kokrajhar district, many such places in Nalbari, Darrang, and Sonitpur districts were visited.

Places with occasional or rare sight records in Dhubri, Goalpara, Nagaon, Kamrup, and Jorhat districts including river islands near Jhanjimukh (26° 55′ N, 94° 23′ E) and areas east of river Kapili around Lanka (25° 55′ N, 92°58′E) were also surveyed (Fig. 2).

Dibru-Saikhowa Wildlife Sanctuary (27° 45′ N, 95° 20′ to 95° 35′ E) located on the southern banks of Brahmaputra in Dibrugarh district, was visited but we could not survey the islands and riverbanks due to flood. Floricans were repor ted to be fairly common on the northern bank of the Brahmaputra in the area but they were scarce in the southern bank even in the last century (Hume and Marshal 1879). Suitable grasslands were not found in the approachable areas of the sanctuary.

Most of the former grasslands in the above areas have completely disappeared, and the few small ones that remain are no longer suitable for floricans.

West Bengal

The Bengal florican was found in West Bengal as far south as Nadia district and was common in North Bengal, Dinajpur and Malda district (Hume and Marshall 1879). Due to spread of cultivation they started disappearing rapidly in the first half this century itself. The last definite record from Nadia was in January 1884 (Baker 1912). By 1935 they had become rare in districts of West Bengal (Baker 1935) and by 1975, had vanished from Malda and West Dinajpur districts as well (Mukherjee 1981).

To know the current status of the Bengal florican in West Bengal, a brief survey was carried out in Malda, West Dinajpur, Darjeeling, Jalpaiguri and Cooch-Behar districts of the state in 1985-86. The survey sites were selected on the basis of available information on former occurrence as well as recent sightings of the bird, and on additional information received during the course of the survey. Cooch-Behar, Darjeeling and Jalpaiguri districts were again visited in April-May 1988 and June 1989 (Fig. 7).

Malda and West Dinajpur districts of central West Bengal are in the fertile Indo-Gangetic plains. Darjeeling, Jalpaiguri and Cooch-Behar are in the *duars* of northern West Bengal which is an extension of *terai* and *bhabar* tracts between Nepal and Assam.

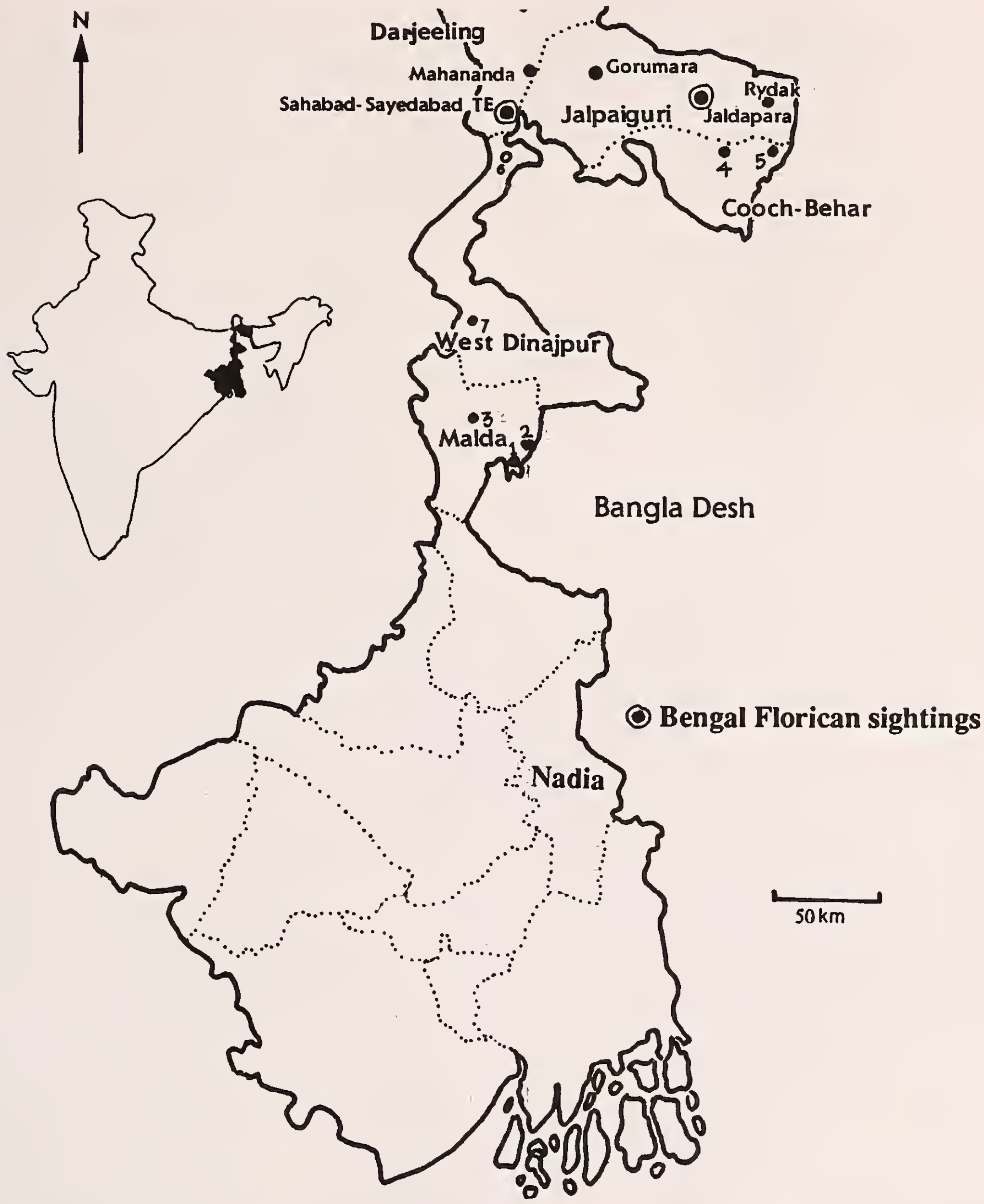

Fig. 7. Survey sites in West Bengal. 1. Singhabad-Tilason, 2. Harishchandrapur, 3. Bhaluka RF, 4. Sonapur, 5. Atiamachar, 6. Chopra, 7. Raiganj.

MALDA DISTRICT

SINGHABAD-TILASON, HARISHCHANDRAPUR AND BHALUKA RESERVE FOREST

Location: Singhabad—Tilason and Harishchandrapur (24°55′N, 88°20′ E) are on the Indo-Bangladesh border along the river Punarbhaba, and Bhaluka Reserve Forest (25°15′ N, 87°55′ E) is about 40 km north-west of Malda town.
Dates of visit: 22 to 24 December 1985.

Habitat: Most of the areas around the first two sites are under cultivation. Small patches of grasslands exist along the river or around the so-called protected forest which seemed like a monoculture of *Barringtonia acutangula*.

Narrow strips or small patches of *Imperata* grassland were also present in the buffer zone of these forest and on the revenue land leased to local landless people. The marshy grassland around the international border along the Punarbhaba river was too disturbed due to livestock grazing, marginal farmers and fishermen.

The Bhaluka Reserve Forest consisted of *Eucalyptus* and *Barringtonia* plantations with understory of grass. Patches of crop and thatch fields were also present in the forest. The villages near the forest had some small thatchfields but no suitable area for florican was found.

Most of these grasslands get flooded during the monsoon. The grasses, including those growing inside the protected forests, are auctioned and harvested around March.

Results: It is almost certain that floricans do not

exist in these areas. The grassland patches in the protected forests were too small and disturbed. The village thatch fields were still smaller.

Inquiries about the Bengal florican, locally called as *dahar* or *charas*, revealed almost total ignorance about this bird among local people. However, one villager near Bhaluka recognised the illustration of the bird and recalled having seen a few of these jumping birds in the grasslands after a major flood in the area some time in the mid-1970s.

West Dinajpur District

Suitable grasslands were not found in this district as the situations were similar to those in Malda district. Although this district was not surveyed extensively, enquiries made it clear that there may be hardly any suitable habitat left for floricans. At the time of writing we received news of the sighting of a Bengal florican in a tea-garden thatch field near Chopra in the extreme north of the district (S. K. Guha, pers. comm.). Mukherjee (1981) too had reported floricans from the flood plains of river Atrai in the area. The grassland pockets are so small and few, like those in Darjeeling district, that there is not much hope for the floricans in the area.

Darjeeling District

The only suitable florican area in this district was found among the thatch fields of two tea-estates. Bengal floricans were eventually seen there during the second visit to the site.

Sahabad–Sayedabad Tea-Estates

Location: 26°35′ N, 88°20′ E. On National Highway 31 about 10 km south of Bagdogra.
Dates of visits: 26 December 1985, 26–27 May 1986, 16 Feb. 1987, 3 June 1989.

Habitat: The area consists of relatively less disturbed thatch fields, and cultivations in an undulating land of about 30 ha between the tea plantations. In December about three-fourths, of this area was covered with 100 to 250 cm tall grass (mostly *Imperata*) and shrubs with a few scattered simul (*Bombax ceiba*) trees. A stream passes through the area.

During the second visit in May 1986, the *Imperata* grass was short and even other grasses and shrubs were small (*c.* 50 cm). *Grewia sapida*, whose fruits are eaten by the florican, were flowering and beginning to fruit. The grasslands were disturbed to some extent due to livestock grazing.

Results: Workers and graziers recognised the florican from illustrations, but said that the birds are seen only after the harvesting of the thatch grass in March-April. It is locally called *Kher menjur* in Sadri by the workers from southern Bihar (*kher* = thatch, *menjur* = peafowl).

The area was visited again in May 1986 and two adult male floricans were sighted, of which one was displaying. No female was seen. It was rumoured that someone had poached florican eggs but no one could tell the location of the nest.

Some Forest Department officials of West Bengal reported seeing a male florican on the grassy banks of Balasan river not far from the tea estates (Sanyal 1988).

We did not see floricans during subsequent visits to the tea estates in February 1987 and June 1989 and the area was considerably disturbed by tea garden workers, their children and cattle. They were ignorant about its endangered status and some openly admitted to killing florican or robbing its nest, and agreed that sightings have become very rare.

The area is owned by the two tea estates and is used for growing thatch and paddy for workers. Thus the efforts to protect the grassland indirectly help the floricans. If proper protection is not provided through educating the people using the area, or if the proposal to bring the area under tea by the estates is not stopped, one of the two or three remaining habitats of the Bengal florican in West Bengal will be destroyed.

Mahananda Wildlife Sanctuary

Location: 26° 50′ N, 88° 30′ E. In Darjeeling District.
Date of visit : 8 May 1988
Forest Types: Moist deciduous forest, east Himalayan upper *bhabar* sal, riparian grassland

Habitat: The whole sanctuary is more or less under thick forest. However, there are some riverine grasslands on the banks and islands of river Teesta.

Results: There is one grassland called Ghoramora which we could not visit due to floods. In the river Teesta, about a kilometre from Ghoramara, there are some big grass-covered islands which may have some floricans. We could not survey these islands due to early floods. It is possible a few floricans exist in these grasslands.

Jalpaiguri and Cooch-Behar Districts

Jalpaiguri and Cooch-Behar districts are contiguous with the alluvial plains of western Assam. The forests consist of *Shorea robusta* intermixed with moist deci duous trees. The forests are replaced by savanna woodland and grasslands in the flood plains along the rivers. It is in these grasslands that the floricans were expected most. During the survey we visited sites where good grasslands were reported.

Jaldapara Wildlife Sanctuary

Locality: 26°40′ N, 89°20′E. Jalpaiguri district.
Size: 118 sq km.
Forest Types: Low alluvial savanna woodland and riverine deciduous forest (Champion and Seth 1968).
Altitude: 60 to 140 m.
Dates of visits : 18 May 1985, 6-7 May 1988, 1-2 June 1989.
Grasslands surveyed: Harindanga glades along Chirakhawa / Hollong river, Torsha Compartments 1, 2 & 3, Bengdaki, Kunjanagar, Sil Torsha, Malangi.

Habitat: Jaldapara is shaped like an inverted 'V' (Fig. 8). Earlier the west arm used to be drained by river Torsha, and the east arm by a much smaller river called Malangi. But now the main stream of Torsha flows through the east arm and Malangi has merged into it. Torsha is fast flowing, not very deep and has few grass covered islands.

The flood plains of the rivers and nalas are also grassy. However, all the grasslands are not suitable for the florican as most comprise of tall grass. The open glades between the tree forests appear suitable but many of these are too small for the bird.

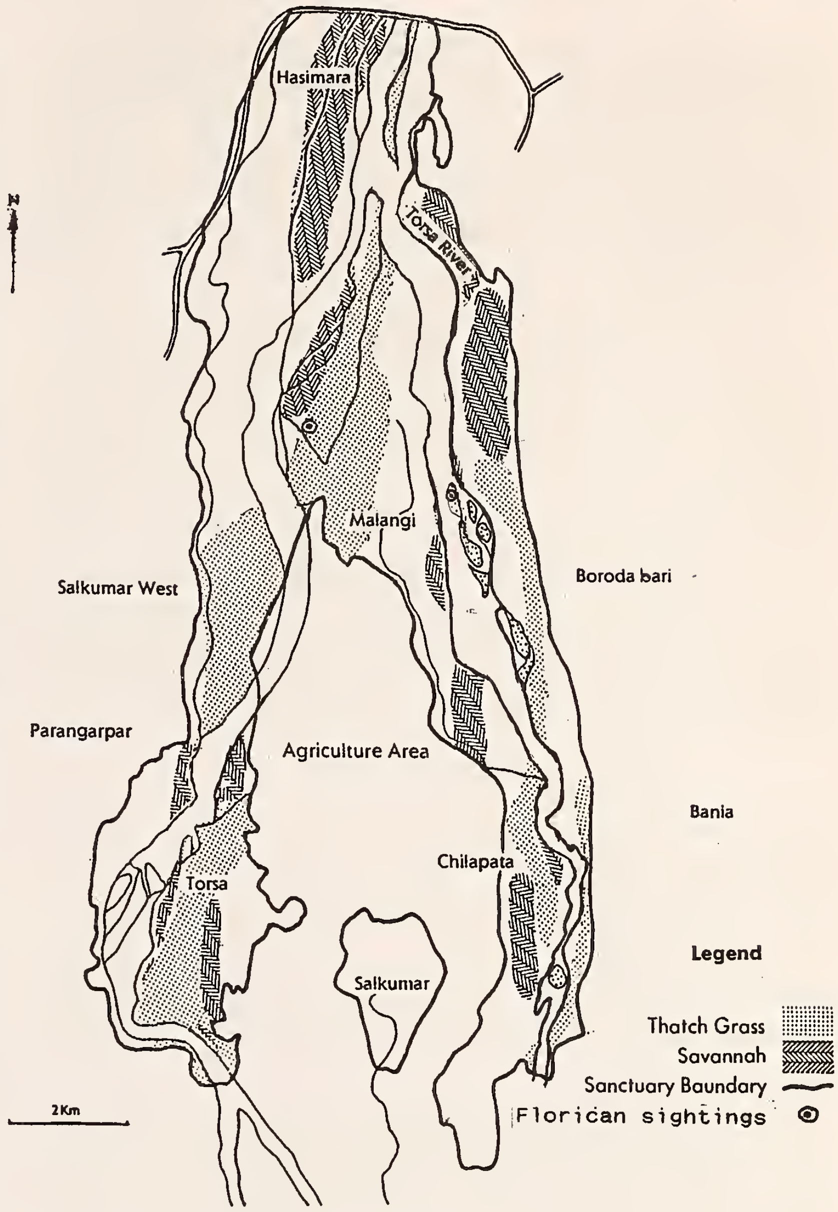

Fig. 8. Jaldapara Wildlife Sanctuary

Results: There are a few good grassland patches in the sanctuary, especially in Harindanga and Torsha Compartments 1 and 3. A few islands on the river Torsha also have good grass cover suitable for floricans.

We could not survey the sanctuary properly in 1985 and till then no confirmed report of florican sightings in Jaldapara was available. In 1988, we saw a male displaying in Harindanga area beside Chirakhawa nala near Hollong. Another cock florican was reported from Mourdanga. In Kunjanagar and Torsha East Camp, two males were seen in 1987 by Forest Department officials. On the evening of 6 May 1988, we surveyed Torsha Compartments and found a few small patches quite suitable for floricans,

though most of the grassland patches had been planted with *Dalbergia sissoo* (most of the trees were either young or stunted). A mahout of the Forest Department who regularly goes for patrolling told us that he saw a florican in that area a few months earlier.

In 1989, most of the short grass patches of the sanctuary were visited on 1 and 2 June. Although only 2 floricans were seen flying over an island in Torsha near Sil Torsha camp, reports of rare florican sightings were available from some other areas like in the previous year.

Cattle grazing and human disturbance are the major problems of the sanctuary's sparse florican habitats and according to our estimates Jaldapara may have not more than 10 floricans.

Gorumara Wildlife Sanctuary

Location: 26°46'N, 88°50' E.
Date of visit: 29 December 1985
Grasslands surveyed: The *chapories* of Murti river.

Habitat: Most of the area has very tall and dense elephant grass with a few patches of smaller grasses and shrubs.
Results: Short open grassland patches of suitable size were not seen during the survey. The sanctuary staff do not remember ever seeing floricans in Gorumara.

Marakata, Narathali and Dangi

Location: 26°45' N, 89°45' E. In the buffer zone of Buxa Tiger Reserve under Rydak Range in Jalpaiguri district.
Dates of visit: 30–31 December 1985

Habitat: Originally there were grasslands along the river Rydak.
Results: The areas were devoid of suitable florican habitat and the few remaining patches of grasslands were highly degraded and disturbed. There was ample evidence of overgrazing by cattle. Trapping of wildlife was also noticed.

Atiamachar and Baro-Bachamari Beel

Location: 26°25'N, 89°40' E. East-south east of Alipurduar in Cooch-Behar district.
Date of visit: 1 January 1986

Results: No suitable habitat was found in the Baro-Bachomari Beel (a wetland) and the Atiamachar areas of Cooch-Behar district. A patch of grassland in the midst of teak plantation at Atiamachar was heavily overgrazed.

Sonapur

Location: 26°30'N, 89°20'E. About 20 km north-west of Cooch-Behar town in Cooch-Behar district.
Date of visit: 1 June 1989

Results: Some areas at Sonapur enclosed and protected for tree plantation by the state Forest Department had good growth of thatch grass. However, the plots were too small for floricans to occur there in spite of their presence in the adjacent areas of Jaldapara WLS.

Bihar

Even in the past the Bengal florican was a fairly uncommon bird in Bihar (Hume and Marshall 1879, Baker 1921). In recent years it has not been seen in the state except for an unconfirmed record from Purnea which was the only district where the bird was not very rare earlier. Presently there are only two sanctuaries — Valmikinagar (462 sq. km) and Udaipur (9 sq. km) in the *terai - bhabar* tract of north Bihar. While Udaipur WLS is a wetland and not fit for florican, Valmikinagar may still have potential florican areas. Moreover, its proximity to Chitwan in Nepal where Inskipp and Inskipp (1983) have seen floricans makes Valmikinagar important for florican conservation. Both the potential florican areas in Bihar were surveyed by us (Fig. 9).

Valmikinagar Wildlife Sanctuary

Location: 27°25'N, 84°E. West Champaran district.
Size: 462 sq km.
Forest types: Semi-evergreen forest, moist deciduous forest, alluvial grasslands, riverine community and wetlands (Rodgers and Panwar 1988).
Date of visit: 11 May 1988
Grasslands surveyed: Madanpura Range, Kotaria nala, Naurangia.

Habitat: The forest of Valmikinagar WLS comes under the typical *terai*, with thick sal forest,

grasslands and swamps. During the last few decades, most of the grasslands have been converted into woodland by tree plantation.

There are two important forest ranges: Madanpura and Gunoli. In the Madanpura range, Compartments 1-3 have some so-called blank areas (grasslands) which have been planted with *Dalbergia sissoo*. About 60 ha of grassland was planted with trees as recently as March 1988. In Compartment 16, in the Kotaria nala some portions are suitable for floricans but being a depression, the nala gets waterlogged during the monsoon. Naurangia grassland near Naurangia nursery was earlier suitable for the floricans but now it has been converted into plantation.

Results: Floricans were not sighted in Valmikinagar WLS though we spent considerable time surveying all the approachable grasslands.

Hariabara Protected Forest

Location: 26°15′ N, 87°25′ E. 50 km north of Purnea town and about 20 km south of the Nepal border in Purnea district.

Habitat: The 170 ha Hariabara PF falls under Araria sub-division and about 80 ha of it is under thatch grass.

Results: According to the DFO of Purnea, Arun Prasad, a male florican was seen by him and the Conservator of Forests in May 1987 among thatch grass of Hariabara field no. 3. We could not see any floricans during our visit on 9 May 1988 but a forest guard claimed to have seen one bird just ten days before our visit. Although the habitat appeared too degraded for a shy bird like the florican, it is possible for a few individuals to stray here as the place is only about 60 km from Kosi Barrage area in Nepal where Inskipp and Inskipp (1985) had seen the bird.

Uttar Pradesh

The whole of north Uttar Pradesh from Haldwani to Gorakhpur was once florican country but now the tract is more or less under human occupation. At present, we can be sure of only two places — Dudwa National Park and Kishanpur Wildlife Sanctuary — where the florican is present, but there are three more areas — Lagga Bagga, Katerniaghat and Sohagi Barwa — where there are good chances of this bird being present. We did a thorough survey of the U.P. *terai* from Pilibhit to Gorakhpur and visited the following areas (Fig. 9).

Dudwa National Park

District: Lakhimpur Kheri
Coordinates: 28° 24′ to 28° 40′ N, 80° 34′ to 80° 49′ E
Size: 614 sq km.
Forest type: Moist deciduous forests, alluvial grasslands
Area under grassland: About 25%
Study period: 17 -21 April 1985, 30 April - 6 June 1987, 22 Jan.- 22 June 1988 and 16 Feb.- 10 July 1989.
Grasslands surveyed: Satiana, Madraiya, Phulvaria, Sonaripur, Seetha Gadhaia, Bhadi, Louki, Salukapur etc. (Fig. 10).

Habitat: The Park has two main rivers, the Mohana and Suheli, which form natural boundaries to the north and south respectively. The Park's water system drains into these two rivers which are tributaries of the Sharda, which in turn is a part of the Ganga river system.

The forests are moist deciduous, being dominated by sal *Shorea robusta*. The forests are interspersed with tracts of low lying grasslands which tend to get flooded during the monsoon. The grasslands had khair *Acacia catechu* as the dominant woody species which by 1905, had mostly been worked out to meet timber needs (District Gazetteer 1905). In the 1950s, under plantation schemes, tracts of grasslands were planted with sheeshum *Dalbergia sissoo*, simul *Bombax ceiba* and *Eucalyptus*. These plantations have mostly been unsuccessful, leaving behind scattered clusters of trees of varying densities. The grasslands (including open forests) occupy about 120 sq. km of the Park.

Results: The present study reveals that the Bengal florican is found in larger numbers than was earlier supposed. A population of at least 40 floricans in the Park is estimated. 19 males were seen, 14 territories (display sites) were located, two immature males were sighted and three adult males were seen, whose territories could not be identified.

Fig. 9. Survey sites in Uttar Pradesh and Bihar. 1. Lagga-Bagga, 2. Mahauf Range, 3. Kishanpur WLS, 4. Dudwa, 5. Katerniaghat WLS, 6. Suhelwa, 7. North Gonda Forest, 8. Sohagi-Barwa, 9. Valmikinagar WLS, 10. Hariabara PF.

The Bengal florican has been recorded from all the five ranges that comprise the Park. This study has located floricans in four ranges: Dudwa, Bankatti, North Sonaripur and South Sonaripur (Fig. 10). The Bellraein range needs more investigation.

We have identified three main florican areas in the Park: (1) Around the Satiana FRH on the border of Dudwa and Bankatti ranges, (2) in the rhino enclosure at Salukapur in the South Sonaripur range, and (3) around the Sonaripur FRH on the border of North and South Sonaripur ranges. Details of locations of the territories, and other sightings are given in Table 3. Grasslands that seemed suitable for the florican and requiring further investigation are given in Table 4.

Sohagi Barwa Wildlife Sanctuary

Location: 27°10′ to 27° 20′ N, 83°35′ to 83° 50′ E. Gorakhpur and Deoria districts
Size: 428 sq km.
Forest Types: Eastern heavy alluvial plains, moist mixed deciduous forest
Dates of visits : April 1985, 15-16 May 1988.
Grasslands surveyed : Nagwa and Sunari.

Habitat: The forest of Sohagi Barwa is broken up into various patches. Most of the original grasslands have come under the plough or are heavily overgrazed. Some suitable grasslands are still present inside the larger blocks of forests, several of which have been planted. Generally the plantations are unsuccessful due to waterlogging, but the practice continues as a regular forestry

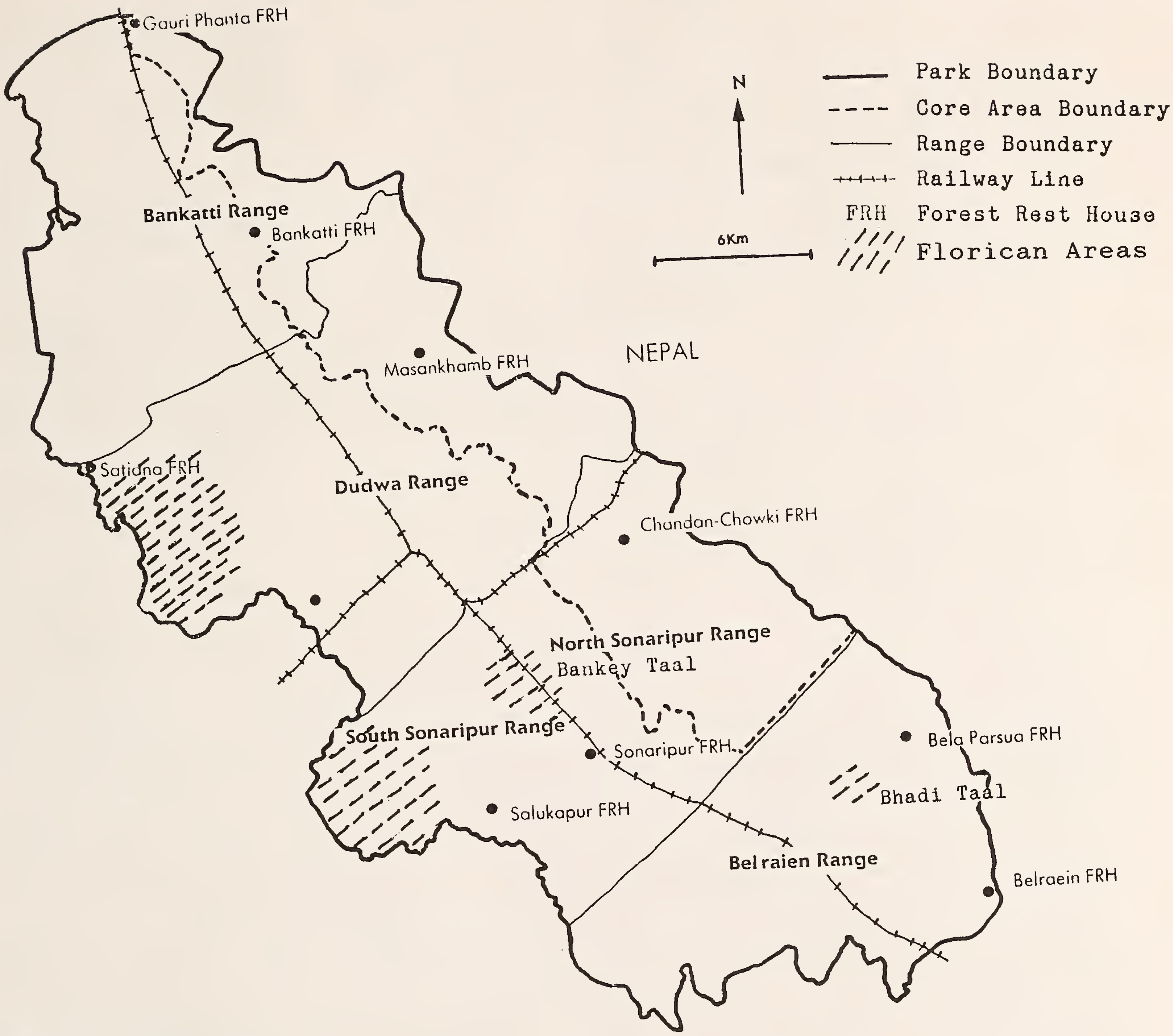

Fig. 10. Dudwa National Park

operation. Sohagi Barwa was declared as a wildlife sanctuary in June 1987.

Results: North Gorakhpur forests, mainly Nichlaul and Sohagi Barwa, were visited during our survey in 1985. We could not see any floricans either then or in 1988 when we spent two days in Matholia range of the sanctuary. However, we suspect that the florican may be present in this region as some grasslands in Nagwa and Sunari blocks have good florican habitat. Compartment16 of Nagwa and Compartment 31 of Sunari adjoin each other and constitute a compact grassland of 262.3 ha. Though half the grassland is already planted with *Dalbergia*, *Syzygium* and *Artemisia*, some parts as recently as 1987, the remaining area has perfect grass cover for floricans. Even the new plantations are good for floricans as they are better protected to save the saplings from livestock.

There is an urgent need to save the natural grasslands of Sohagi Barwa WLS, which are the prime candidates for reintroduction or recolonization by the Bengal florican. Sohagi Barwa is connected with Valmikinagar WLS in

TABLE 3
LOCATION OF MALE BENGAL FLORICANS IN DUDWA NATIONAL PARK

Range	Region	Location of males	No. of territorial males	Other males	Dates of sighting	Remarks
Dudwa	Satiana FRH	*c.* 400 m west of Kowhagatti bridge on southern side of road	1	–	Feb.-June 1988	–
"	"	In Chapra phanta on southern side of road	1	–	"	–
"	"	In Madraiya near 'pukka' machan	–	One adult	30 April 1988	Seen in flight
"	Sarota Beat	Phulvaria phanta; southern side of Dudwa Masankhamb forest road	1	–	Feb.-June 1988	
Bankatti	Satiana FRH	Navalkhad phanta	2	One	Feb-June 1988	Imm. male seen on 27 Feb.'88
Sonaripur (North)	Sonaripur FRH	Seetha Gaddaia phanta on Rd. no. 64 between FRH and Dudwa-Chandan Chowki metalled road	2	One	25 May 1988	All 3 males seen simultaneously
Sonaripur (South)	Sonaripur FRH	In grassland just west of FRH between FRH and railway station	2	–	"	–
"	"	Bankey taal	–	One adult	26 May 1988	Near Rly. track
"	"	Bankey taal	–	One imm.	16 June 1988	Savarkar (pers. comm.)
"	"	In grassland east of FRH on Rd. no. 64 going to Salukapur	1	–	26 May 1988	–
"	Salukapur Rhino Enclosure	Chetwa phanta adjacent to FRH Kakraha road	1	–	Mar.-June 1988 (periodically)	–
"	"	Kurmania phanta	1	–	"	–
"	"	Parbhatia machan phanta	1	–	5 & 6 May 1988	–
"	"	Bela phanta	1	–	6 May 1988	–

TABLE 4
DUDWA GRASSLANDS REQUIRING FURTHER INVESTIGATION

Range	Grassland	If present in the past	Information given by	If seen recently	Visited by us or not
Bankatti	Dankhera	Yes	Amar Singh	No	Yes
Sonaripur (North)	Lohti	Yes	*Tharus*	?	Yes
Sonaripur (South)	Louki	?	–	Yes females	Yes
Bellraien	Sathanatha	Yes	*Tharus*	?	Yes
"	Kusumba Chowki	Yes	Balram Singh	No	Yes
"	Bhadi Taal	Yes	Ashok Singh	No	Yes
"	Churela Taal	?	–	No	Yes

Bihar and is close to Chitwan in Nepal where the Bengal florican is present.

SUHELWA WILDLIFE SANCTUARY (Proposed)

Location: 27°40′ N, 82°14′E . Bahraich and Gonda districts.
Size: 450 sq. km.
Forest Types: Terai and *bhabar* sal forest and wetlands.
Date of visits: 17 May 1988
Grassland surveyed: Ghabapur *chapa.*

Habitat: It is a typical *terai* forest dominated by *Shorea robusta* in drier areas. *Saccharum, Themeda, Imperata* and *Vetiveria* are the common dominant grasses in the open areas where the trees of *Bombax ceiba, Acacia catechu* and *Terminalia tomentosa* are also found.

Results: We visited a small grassland, the Ghabhapur *chapa*, in Katkunya beat of west Suhelwa. The main grass, *Vetiveria,* is auctioned by the Forest Department. Since 1980, *Acacia catechu* has been planted in the grassland which, though mainly unsuccessful, has destroyed the natural characteristics of the grassland, possibly resulting in the disappearance of the florican.

Once the forests are declared as a sanctuary and all the natural features of Suhelwa are protected, there are chances that the florican may appear in some of the grasslands.

NORTH GONDA FOREST

Location : 27°45′N, 82° 45′E (approx.). Gonda district.
Forest Types : Typical *terai* forest.
Date of visit : 16 May 1988.
Grasslands surveyed: Beerpur and Bhagwanpur Beats.

Habitat: The typical sal forest of the *terai* is seen in North Gonda. According to the local DFO, most of the grasslands have been planted. Beerpur Beat has a dam reservoir.

Results: 1. *Beerpur Beat, Bhabar Range*: Grasslands in this area are all under heavy grazing pressure. The grass and grazing rights are auctioned by the Irrigation Department annually. Grass grows in the dry areas of the reservoir but is soon grazed by the village cattle. There was one small patch of grassland of about 10 ha abutting the forest but there is practically no chance of floricans living in such a disturbed area.

2. *Plantation in Bhagwanpur Beat:* This elongated 40 ha grassland has been planted over in 1985 and 1987. Owing to protection from grazing (to protect the saplings), good grass cover was present in the 1985 plantation. Survival of trees was nearly 75% but most saplings were stunted, thus giving the appearance of a savanna. The small area is disturbed by movement of villagers on the nearby forest road. The florican is unlikely to have survived in the face of so many detrimental factors.

KATERNIAGHAT WILDLIFE SANCTUARY

Location: 28°15′ N, 81° 16′ E. Bahraich district.
Size: 400 sq km
Forest type: Typical terai forest of semi-evergreen, moist deciduous, alluvial grassland, wetlands and riverine community.
Dates of visits: 26-27 April 1985, 9-12 April & 18-19 May 1988.
Grasslands surveyed: Around Katerniaghat Forest Rest House.

Habitat: Katerniaghat was declared a wildlife sanctuary in 1976 for the specific purpose of protecting the wildlife of the area, which was threatened due to the irrigation projects on the Ghagra river and the resultant human disturbance. The sanctuary is located nearly 30 km east of Dudwa NP near the Indo-Nepal border.

Large open patches of grasslands are present around the Katerniaghat Forest Rest House, and on both sides of the Katerniaghat-Girija bund road. Overgrazing by livestock is one of the major disturbances to the grasslands here. Moreover, a huge area near Katerniaghat FRH is now occupied by a Government Seed Farm.

Results: Though Katerniaghat was surveyed both in 1985 and in 1988 floricans were not located in spite of some of the remaining habitat being apparently suitable for these birds. If grazing is banned during the breeding season (February to June), the bird might appear here. Its proximity to Dudwa and Royal Bardia (Nepal) makes it suitable for recolonization by the florican. Floricans were seen in Katerniaghat a decade ago and some of them might still be present or visiting in certain months.

KISHANPUR WILDLIFE SANCTUARY

Location: 28°27′ N, 80° 22′ E. Lakhimpur Kheri district.
Altitude : Around 200 m
Size: 227 sq km.
Forest Type: Semi *terai* forest with extensive sal forest, grasslands near river beds and wetlands.
Dates of visits : 21-22 April 1985, 24-25 May and 29-30 May 1988.
Grassland area surveyed East Kishanpur, Jhadi Tal, North Kishanpur, Puayan, Madha Block (Mailani) and Dhanha *chander*.

Habitat: Kishanpur was declared a Wildlife Sanctuary in 1973 and came under Project Tiger in 1988. Open grasslands (*chander*) are present throughout Kishanpur WLS although many have been converted into woodlots by tree plantations. Most of the grasslands are in the depressions representing the abandoned beds of old rivers (probably of the Sharda).

Results: As Kishanpur WLS is close to Dudwa and has potential florican grasslands, almost all important grasslands were surveyed. Though floricans were not seen, it is likely that they are present in some areas. On 25 April 1990, a Bengal florican was seen in flight in crop fields adjacent to the Kuthar diversion in South Kheri Forest Division (S. P. Sinha, pers. comm.). This area is contiguous with the sanctuary. It is possible that this individual came from the sanctuary. The following areas have good potential:

1. *East Kishanpur, Compartment 2A :* About 1 km from the Kishanpur FRH, there is a 30 ha grassland which was planted a few years ago but none of the saplings survived. Presently it is under grass cover and the height of grass growing in clumps was between 70 and 90 cm.

2. *Jhadi Taal :* About 4 km from Kishanpur FRH is the main swamp deer area called Jhadi Taal. It is a depression about 2 km long and 1 km wide. Owing to the drought in 1987 Jhadi Taal had dried up, resulting in growth of grass, and we saw 83 swamp deer *Cervus duvaucelli duvaucelli.*

3. *East Kishanpur, Compartment 2B:* A 30 ha grassland plot adjoining Jhadi Tal was planted with *Eucalyptus*, *Tectona* and *Dalbergia* in 1987 and protection from cattle and fire has resulted in a dense growth of grass. Near this plot is a 16 ha Gram Samaj land of the abandoned Raikhera village and about 2 km away is Kishanpur village (population 1500, livestock 400-500), so the area is not undisturbed.

4. *North Kishanpur, Compartment 3B and Puayan grassland:* North Kishanpur Comp. 3B is small (17 ha) and in 1987 the grassland was planted over by *Eucalyptus* and *Dalbergia* so the habitat is no longer suitable for florican. Near Comp. 3B, on the other side of the forest road is a larger 100 ha grassland (under Puayan range) which appears to be suitable for florican; unfortunately, this grassland is also being altered by massive tree plantation. Nearly 100,000 trees were to be planted during the monsoon of 1988. A part of the Puayan grassland is on the bed of Ull river, and is covered with tall, very densetall thatch grass. Slightly higher areas, under short grass, were more suitable for florican. These areas have been marked for afforestation.

5. *North Kishanpur, Compartment 1* : There is a small 45 ha grassland adjoining to which is a small human settlement and forest. This plot was also planted in 1987 with *Azadirachta indica*, *Tectona grandis*, *Dalbergia sissoo* and *Terminalia tomentosa*.

6. *Dhanha grassland:* 5 km from Mailani on Bhira road there is another excellent grassland known as Dhanha *chander.* It is nearly 4 km long and 800-1000 m wide but four of us walking through it could not flush any florican.

7. *Madha Block (Mailani Range):* One of the best and most promising grasslands for floricans in Mailani range is in the Madha Block. It is about 143 ha and extends on both sides of the Singhaghoru road. During our visit on 29 May 1988 when five people searched for the floricans the grass height was 50-70 cm. Being inside the forest the grassland is undisturbed. Near Madha grassland on Madha-Burgad Chowki road there is another grassland which is suitable for floricans[1].

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[1]Three male Bengal floricans were spotted in Kishanpur WLS on 2 and 3 May 1991. The first, a territorial male, was seen on Madha grassland when it made a display leap. The other two were located on a grassland near Bugad-Chowki.

Pilibhit District

Some of the best *terai* forests of Uttar Pradesh can be seen in Pilibhit district, and especially in Mahauf and Mustafabad ranges. North Pilibhit consists of nearly 550 sq. km and South Pilibhit 400 sq. km of sal and mixed forests. About 100 sq. km of the North Pilibhit forest was grassland which has since 1962 been converted into plantations. Due to the failure of *Eucalyptus* plantations done between 1962 and 1980, the Forest Department is now planting teak. In the protected plantation blocks where *Eucalyptus* had failed, natural growth of sal is coming up.

Grasslands in this area too are called *chander.* As all the grasslands have been planted, teak plantation is now being done under the existing trees in the degraded forests.

Mahauf Range (North Pilibhit)

Location: 28° 35′ N, 80° 10′ E (approx.)
Forest Types : Typical sal dominated *terai* forest, with grasslands and wetlands.
Date of visit: 25 May 1988.
Grasslands surveyed: Compartment Nos. 13 and 106.

Results: We visited the following two areas which have some semblance of the former grasslands:

1. *Compartment No. 13:* This grassland of about 300 ha was extensively planted with *Eucalyptus* which has failed. The forestry operations have destroyed the natural features, but if the trees are removed, the area can again become a grassland. Coppicing of *Eucalyptus* was done only once and two more coppicing will be done. After the third coppicing *Eucalyptus* will be dug out and the area will be left fallow for few years and then planted again. It will be interesting to see if floricans will return to this grassland during this intervening period.

2. *Compartment No. 106:* The original grassland patch in this compartment consisted of about 480 ha. Like Compartment No. 13, *Eucalyptus* plantations were done in 1970-71 but were unsuccessful. However, *Eucalyptus* plantations done in the early 1980s were more successful and totally altered a good florican area.

Lagga-Bagga (Mustafabad Range)

Location: 28° 46′ N, 80° 09′ E
Size: 11 sq. km.
Forest Type: Sal and mixed forest, alluvial grasslands and wetlands.
Dates of visits: 26-27 May 1988
Grassland area surveyed: Naryaliya and Lagga-Bagga Beats.

Habitat: Lagga-Bagga is located on the Indo-Nepal border adjoining Sukla Phanta Wildlife Sanctuary of Nepal in the north-east. In the south and south-east the Sharda river forms a loop around it. The forest and grasslands of Lagga-Bagga form a continuous stretch with Sukla Phanta.

Nepali graziers freely enter Lagga-Bagga to hunt, fish and graze their cattle. Moreover, Bengali settlers on the Indian side also use this tiny belt of forest for fuel and fodder needs. We were told that the authorities of Sukla Phanta are very strict, and so the habitat and wildlife is well protected on their side.

Results: In spite of a two day search we could not locate any florican in Lagga-Bagga although we are almost certain that it is present, mainly because it was seen in the contiguous grasslands of Sukla Phanta by Inskipp and Inskipp (1983, 1985). Due to inaccessibility, we could not reach Lagga-Bagga during the display time of the florican (i.e. early morning and late evening), ideal for locating territorial males. Of the three main *chanders* the first is not very suitable for floricans as the grass was too tall (150 to 200 cm) and dense. The second grassland is excellent for floricans with short thatch grass of less than 100 cm in the middle (on the ridge) surrounded by taller grass on the stream beds, followed by thick forest. The third compartment adjoins the vast grassland of Sukla Phanta and is the most suitable for floricans.

Status of the Bengal Florican

While it is difficult to accurately estimate the number of Bengal floricans surviving in India, it is certain that there are more birds than estimated earlier. For instance, Deb Roy (1985, pers. comm.) estimated that 34 birds

were present in Manas. However, we estimate that there are not less than 80 floricans in Manas. Similarly, we estimated that less than 20 floricans survived in the whole of Uttar Pradesh. Subsequent to intensive studies at Dudwa, we found that at least 35 to 40 were present. Inskipp and Inskipp (1983,1985) saw 35 to 50 floricans in Nepal and they estimated a total population of 100 birds in that country. We believe that there are between 250 to 300 Bengal floricans in India, which brings this bird to a precarious world population of about 400.

Recommendations

The loss of habitat seems to be the main threat to the Bengal florican. As more and more grasslands are acquired for cultivation either legally or by encroachment, the shrinking habitat brings the florican in direct conflict with man. Unlike the other two bustards breeding in India the Bengal florican stays away from cultivation and even if it does nest rarely in the village thatch fields or certain crop fields, the chances of destruction of the eggs during weeding or harvesting are always high. Overgrazing and late burning of the grasslands are the major danger to the florican habitat, though these are well under control in sanctuaries like Dudwa, Manas and Orang. In some of the reserve forests e.g. North Pilibhit and North Gorakhpur, the 'blank' areas (natural grasslands) have been afforested and are no longer suitable for the florican. Nevertheless, there are still some grasslands which if managed and protected properly, could be re-colonized by the Bengal florican. Some of these grasslands are near areas where the florican is still present. We recommend that such grasslands should be managed for the conservation of the florican and tree plantation should be strictly avoided. Specific recommendations for each area visited by us are given elsewhere (Rahmani *et al.* 1988). The following are some of the general recommendations:

Protection of natural grasslands in the whole terai belt and the Assam valley with special emphasis on the Brahmaputra islands and flood plains. Proper maintenance of open grassland by timely burning and/or harvesting.

Ban on tree plantation in suitable grasslands. Restoration of the presently degraded grasslands and strict control on grazing and untimely burning/harvesting.

Introduction of large scale thatch cultivation at least in areas not suitable for paddy.

Protection against shooting and trapping. Generating awareness among people regarding the florican's extremely endangered status.

Regular monitoring of florican populations in all major habitats by Forest Department staff and maintenance of sighting records.

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Addendum

Arunachal Pradesh

At least till the first quarter of the present century the Bengal floricans were recorded in fair numbers from Sadiya plains including areas along the southern boundaries of Siang and Dibang districts of Arunachal Pradesh bordering Lakhimpur district of Assam. According to Colonel Graham the floricans were found in small numbers right upto the foot of Abor, Mishmi and Dafla Hills east and north of Sadiya (Hume and Marshall, 1879). (Sadiya town: 27° 50′ N, 95° 42′ E). Baker (1921) has mentioned the grasslands and '*churs*' bordering Dihang, Dibang and Brahmaputra rivers upto the

foothills as the eastern most limit for the bird. Due to technical reasons we could not survey these areas.

Pandya (pers. comm.) carried out a survey of the grasslands of D'Ering Memorial (Lali) Wildlife Sanctuary (27°55′ N, 95°25′ E) in East Siang district. He counted 12 Bengal florican males between 11 and 25 April 1990. It is possible that there are 20 to 25 floricans in this sanctuary which is located on the islands of Dihang (Siang) river north of area where Dibang (Sikang), Sesar and Lohit rivers join it to form Brahmaputra. Dibru-Saikhowa Wildlife Sanctuary of Assam is located just south of this point.

References

Ali, S. & Ripley, S.D. (1969): Handbook of the Birds of India and Pakistan, Vol. 2. Oxford University Press, Delhi.

Ali, S. & Rahmani, A.R. (1982-84): Study of Ecology of certain Endangered Species of Wildlife and their Habitats. The Great Indian Bustard. Annual Report 2. Bombay Natural History Society, Bombay.

Baker, E.C.S. (1912): The Game Birds of India, Burma and Ceylon, part VIII. *J. Bombay Nat. Hist. Soc. 21:* 1109-1128.

Baker, E.C.S. (1921): The Game Birds of India, Burma and Ceylon, vol. II. Bombay Natural History Society, Bombay.

Baker, E.C.S. (1935): The Nidification of Birds of the Indian Empire. Vol. 4. London.

Champion, H.C. & Seth, S.K. (1968): A Revised List of the Forest Types of India. Govt. of India Publication Division, New Delhi.

District Gazetteer (1905): United Province of Agra and Oudh, Vol. XLII. Government Press, Allahabad.

Hume, A.O. & Marshall, C.A.T. (1879): The Game Birds of India, Burmah and Ceylon. Calcutta.

Inskipp, C. & Inskipp, T. (1983): Report on a Survey of Bengal Florican, *Houbaropsis bengalensis* in Nepal and India, 1982. ICBP Study Report No. 9. 221, International Council for Bird Preservation, Cambridge.

Inskipp, C. & Inskipp, T. (1985): A survey of Bengal Florican in Nepal and India, 1982. Bustard Studies 3: 141-160.

Khan, M.A.R. (1982): Wildlife of Bangladesh: A Checklist. Dhaka University, Dhaka.

Kushwaha, S.P.S. & Madhavan unni, N.V. (1986): Application of remote sensing techniques in forest cover monitoring and habitat evaluation—A case study at Kaziranga National Park, Assam. *In*: Kamat, D.S. & Panwar, H.S. (eds.), Wildlife Habitat Evaluation Using Remote Sensing Techniques, 238-247. Indian Institute of Remote Sensing and Wildlife Institute of India, Dehra Dun.

Manakadan, R. & Rahmani, A.R. (1986): Study of Ecology of certain Endangered Species of Wildlife and their Habitats. The Great Indian Bustard, Annual Report No. 3 1985-86. Bombay Naturtal History Society, Bombay.

Mukherjee, A.K. (1981): The Bengal Florican *Eupodotis bengalensis bengalensis* (Gmelin) in eastern India. Proc. Wildl. Workshop. pages 119-120.

Rodgers, W.A. & Panwar, H.S. (1988): Planning a Wildlife Protec ted Area Network in India. 2 vols. Wildlife Institute of India, Dehra Dun.

Rahmani, A.R., Narayan, G., Sankaran, R. &Rosalind, L. (1988): The Bengal Florican, Status & Ecolgy, Annual Report 1986-87, Bombay Natural History Society, Bombay.

Sankaran, R. & Rahmani, A.R. (1986): Study of Ecology of certain Endangered Species of Wildlife and their Habitats, The Lesser Florican, Annual Report No.2 1985-86: p. 41. Bombay Natural History Society, Bombay.

Sanyal, P. (1988): "Dahar" Bengal Florican (in Bengali): Banabithi, 4: 7-8, Department of Forests, Govt. of West Bengal, Calcutta.

ON THE NATURAL DISTRIBUTION OF THE RARE TREE FROG *RHACOPHORUS TAENIATUS* BOULENGER, 1906 (ANURA:RHACOPHORIDAE), WITH NOTES ON ITS BIOLOGY AND OSTEOLOGY[1]

Pranjalendu Ray[2]

(With eight text-figures)

Rhacophorus taeniatus was originally described by Boulenger (1906) from Purnia (Bihar) based on two examples. Subsequent to the original report this rare tree frog was recently rediscovered from the Dudwa National Park in Uttar Pradesh. The present observation extends the range of natural distribution of this tree frog from north-eastern to north-western India, especially in the terai region of Uttar Pradesh. Its natural habitat, morphological features, sexual dimorphism, osteology, food and feeding habits, etc. are discussed. Suggestions for its inclusion in Schedule I of the Wildlife (Protection) Act of India, are also given. A lectotype is also designated.

Introduction

New information about *Rhacophorus taeniatus* Boulenger is desirable since this tree frog has been rarely noted in literature. In his revision of genus *Rhacophorus* of the world, Wolf (1936) surmised that only the two syntypes from Purnia (Bihar) are known. During a recent survey of Dudwa National Park, Uttar Pradesh, I collected 14 specimens of *R. taeniatus*. This additional material brings to 16 the total number of specimens of *R. taeniatus* known. They allow me to augment the original description and offer good illustrations as well as extend the range to the terai region of Uttar Pradesh.

Wolf (1936) stated that it is 'only found once from the type locality'; Gorham (1974) documented its distribution as "Asia" and Inger and Dutta (1987) erroneously noted its distribution as "West Bengal". The present record of the species in the Dudwa National Park (28° 21′ to 28° 42′ N, 80° 31′ to 80° 56′ E) constitutes the first record outside the type-locality. Boulenger's (1906) account of the species, though sufficient at that time, is now inadequate to identify the species amongst large number of specimens of different age and sex. Of the two syntypes, one is in the repository of the Zoological Survey of India, Calcutta and the other in the British Museum (Natural History).

I have studied the syntype in the Zoological Survey of India, Calcutta, and coupled with extensive field observations of the habitat, call and reproductive behaviour in nature, redescribe *Rhacophorus taeniatus* on the basis of the new material. The syntype in the British Museum (Natural History) is designated as the lectotype; and the syntype present in the Zoological Survey of India becomes the paralectotype *vide* Article 74 (a) of the International Code of Zoological Nomenclature.

Systematics and Biology

Rhacophorus taeniatus Boulenger (Figs. 1-8)

Rhacophorus taeniatus Boulenger, 1906, *J. Proc. Asiat. Soc. Beng.*, (N. Sr.), 2: 385 (type-locality : Purneah, Bengal).

Material examined: i) Syntype (SVL 46 mm), Zoological Survey of India, Calcutta, Registration No. 15715, herewith designated as Paralectotype; *Coll.* W. Partridge.

ii) INDIA: Dudwa National Park, District Lakhimpur-Kheri (Uttar Pradesh); 3 females and 4 males, Sathiana forest near Sathiana Forest Rest House, 11 June 1987, *Coll.* P. Ray, Regd. No. ZSI/NRS-A 188; 4 females and 3 males, Near Belraien Forest Rest House, 21 July 1986, *Coll.* P. Ray, Regd. No. ZSI/NRS-A 189.

Diagnosis: (SVL 42-45 mm O; 35-38 mm O) Slender smooth-skinned arboreal rhacophorid. Tip of snout acuminate, nostrils nearer to the tip of snout than the anterior corner of eye. Vomerine

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[1]Accepted April 1991.

[2]Zoological Survey of India, Northern Regional Station, Dehra Dun 248195.

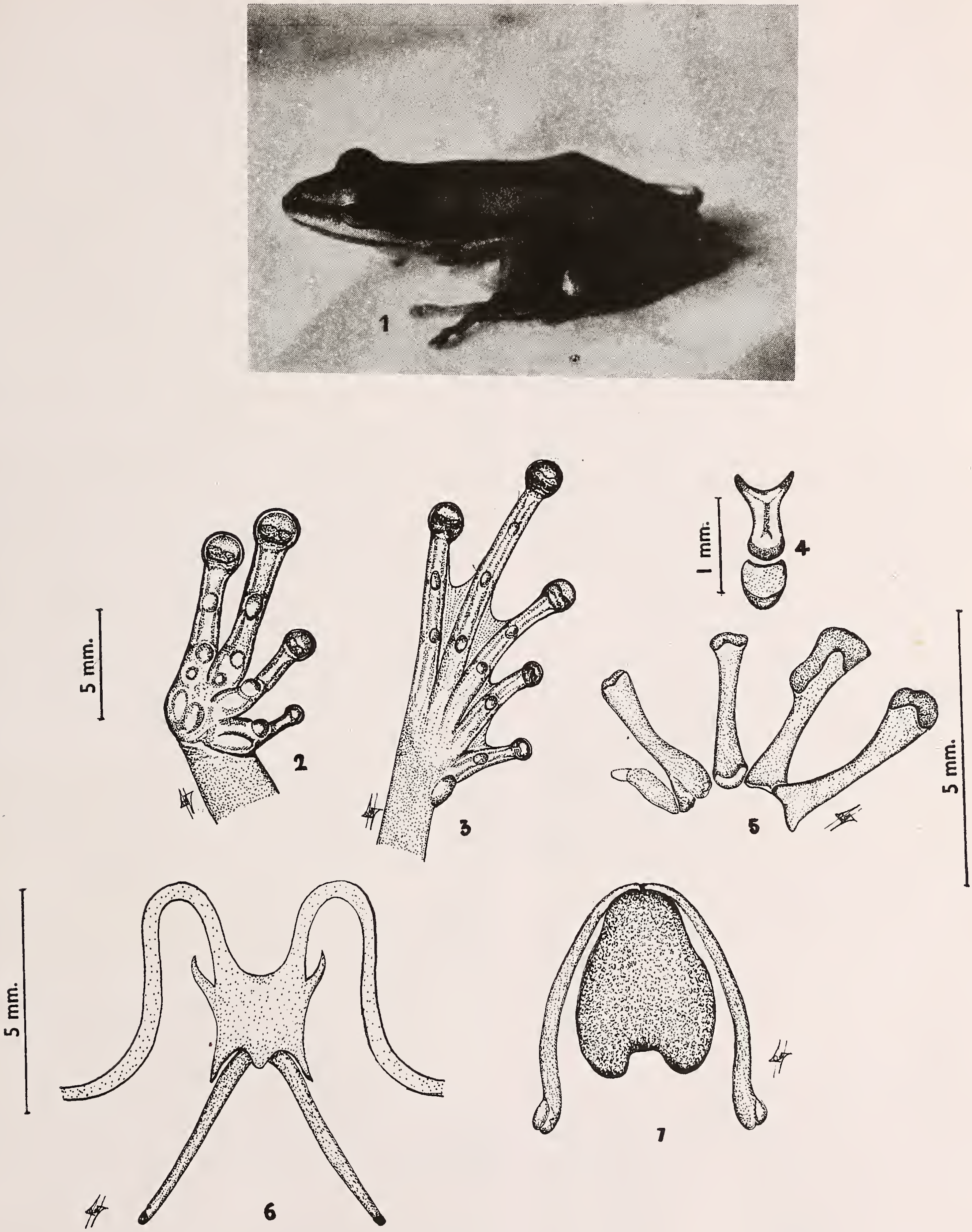

Fig. 1. *Rhacophorus taeniatus*
1. Dorsal aspect, 2. Hand, 3. Foot, 4. Last phalange of third finger, 5. Metacarpals, 6. Hyoid, 7. Tongue with lower jaw.

teeth in small groups in between choanae. Loreal region vertical. Tongue broad and fleshy, narrower in front and wider behind where it is prolonged at each angle to form two cornua; gap between two cornua almost equal width of a cornua. Head length 1.0-1.1 times its width and 3.3-3.6 times Snout to Vent Length (SVL). Diameter of eye 1.3-1.7 times length of snout; tympanum 1.3-1.5 times eye diameter and internarial distance 1.0-1.2 times interorbital width.

Fore limbs slender 1.0-1.7 times SVL; fingers with well developed digital disc bearing distinct circum-marginal groove on outer and inner margin; digital disc of third and fourth fingers larger than first and second. Length of first finger 1.25-1.5 times length of second finger; third finger longest, fourth almost equal to the length of snout. Subarticular tubercles of third and fourth fingers well developed and larger than the rest; additional tubercles present below proximal subarticular tubercle; twin outer palmer tubercle distinct. Hind limbs long and slender, 0.7-0.75 times SVL; diameter of tibia 4.2-5.0 times its length. Foot length almost equal to length of tibia in males, but in females shorter than tibia, tips of toes with distinct discs, but its diameter less than the diameter of discs of third and fourth finger. Tibio-tarsal articulation extends well beyond anterior margin of eye; webbing in between toes less than half, two digits in all toes except three digits of fourth toe devoid of web. Subarticular tubercles distinctly elongate, almost equal in dimension. Inner metatarsal tubercle elongate and 2.5-2.6 times length of first toe. An extensive anal dermal flap present just above the anus. Skin of abdomen and the ventral aspect of thigh act as an adhesive apparatus while sitting adpressed with the substratum.

Colour: In life, dorsal side brilliantly coloured with dark brown, a faint black median line on the anterior side of head, shiny golden yellow longitudinal band spread over tip of snout on each side, runs through the upper eyelid and laterodorsal aspect of body and continues up to coccygeal region; similar band runs along outer margin of femoral and tibial regions. The bands of body and legs are so beautifully oriented that they look like a confluent band, while the animal is resting. On each side below this shiny laterodorsal band a dark brown longitudinal band runs from the loreal region below the tympanic area and continues up to the groin. Inner margins of dark brown dorsal and lateral band shows darker hue which contrasts with the golden-yellow band. Ventrally white impregnated with aeriolar glands of yellowish hue.

Since the longitudinal bands camouflage them in the tall grasses (*Typha elephantiana*), it becomes very difficult to locate them in their habitat unless they move. While sitting they blend so well with the stem that it is difficult to spot them because in the same habitat grasshoppers of similar coloration move about.

Sexual dimorphism: Adult breeding males are markedly smaller than the females. Males have a distinct inflatable vocal sac below the floor of mouth and when the frog calls the sac is dilated and acts as a resonator. The sac is externally covered with a layer of striated muscular fibre derived from mylo-hyoid muscle. Sexual dichromatism is exhibited, with brighter colouration in males than in females. The length of the foot is less than the tibia in males, versus equal in length in females.

Osteology: Some salient osteological features are: skull width almost equal to its length, triangular in shape; length of skull almost equal to the length of urostyle; maximum diameter of orbit equal to distance from tip of premaxilla to anterior margin of orbit; nasal broad anteriorly, rests upon the nasal-cartilage; inferior surface of premaxilla and maxilla with single row of teeth along the margin; outer border of vomer with three processes interspersed two notches, the hinder notch bounding the posterior nares, spoon-shaped inner portion bears irregular row of small blunt teeth on its ventral surface. Cartilaginous body of hyoid squarish, pointed elongated processes project from anterior and posterior corners of each side; anterior cornua projects from anterior margin of hyoid body, first forward then takes a backward curve and again an upward direction to unite with the cartilage of the prootic bone; bony rods project

as posterior cornua which run from the hind margin and diverge posteriorly to enclose the larynx. Omosternal style with a ventromedian ridge, bears spade-like cartilage on the distal end and forked at the proximal end; each fork rests on the clavicle. Xiphisternum an elongated rod of cartilage ensheathed in bone and bears a small round piece of cartilage on distal end. Epicoracoid a pair of narrow cartilage closely applied to each other and placed between the ventral end of the precoracoid and epicoracoid. Suprascapula with broad semicircular outer margin and narrow thickest border articulating with scapula. Metacarpals second and third of almost equal length, shorter than fourth and fifth. The fourth metacarpal shows a distinct dilation on the inner side of distal end. Short and expanded deltoid ridge of humerus in males. Intercalary cartilage between two distal phalanges of fingers and toes present. Terminal phalange bifurcate, more or less Y-shaped, both the arms of which are inwardly curved at tip and main stalk with ventromedian ridge. Vertebral column procoelous and moderately long.

Call notes: Being strictly nocturnal, they are active after dark during the monsoon months (July-August). Male frogs can only be located while they emit a specific vocal sound *thrrik-thrrik — thrik thrik thrik* in or near vegetation. Only a trained ear can successfully distinguish them from chorus calls of several other frogs and toads and also orthopterans of different kinds.

Food and feeding habits: Their food and feeding behaviour in captivity were observed. These tree frogs exhibit diet preference for nocturnal insects like cockroaches, spiders, ants, grasshoppers and small hemipterans. The study of preserved specimens revealed that the stomach contents of females had more food-items than males. It is probable that the males were caught while calling, which inhibits them from catching prey. The food items were primarily spiders, grasshoppers, geophylids and aphids.

Habit and habitat: In Dudwa National Park these rare tree frogs are widely distributed, but their concentration near Sathiana and Belraien was apparent. During the monsoon period a fairly good number of frogs appeared at night near the forested patch, but it was not possible to detect them by day near the site where they were observed at night. Their presence at night at these sites may perhaps be attributed to the fact that the males emit a specific breeding call within the tall grassy patch near dense sal *Shorea robusta* forest with considerable undergrowth of herbaceous plants.

While they can be fairiy easily located by powerful torch-light, they stop their vocal display which makes them almost impossible to locate because of their harmonising coloration and sitting posture. The males being more active and agile, one can locate them only when they jump from one twig to the other. These rhacophorids are very much frogs of the night, spending the day in a secluded retreat inside a hollow tree or in the obscurity of dense foliage, and coming out at dusk to hunt prey, mainly nocturnal insects. Captive frogs display their activity only at night; by day they usually take shelter beneath the broad leaves and also within the hollow space in between the petiole and stem of tall elephant grasses. It was also noted that their jumping activity starts at dark rather than by day when they prefer crawling on stems. During the day they do not feed on insects supplied to them. Their preference for moist swampy conditions at night was evident by their behaviour in captivity. Their coloration looks dull by day, but appeared bright when observed at night with a torch-light.

Conservation: Recent forest management practices of burning the over grown grasses during summer poses a great threat to the fauna which takes refuge for its survival from nearby areas perpetually encroached by man and domesticated livestock, depleting the natural forest ecosystem. Hence this terai grassland that stretches across the Himalayan foothills has been under sustained biotic pressure. A substantial portion of grassland has already been converted into agricultural land. Some areas that have escaped this onslaught have been earmarked for conservation of bigger animals.

The effect of management practices like burning on smaller groups of ecologically diverse, viable species has not been given due attention. This rhacophorid is most uncommon and, therefore, a study on its ecology would be both interesting and challenging. A sustainable population of these remarkably adapted tree frogs need protection. In view of the above mentioned facts its inclusion in Schedule I of Wildlife (Protection) Act of India, is recommended.

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REFERENCES

AHL, E. (1931): *Das Tierreich*, Anura III, Polypedatidae. De Gruyter, Berlin and Leipzig.

BOULENGER, G.A. (1906): Description of two new Indian frogs, Calcutta, *J. Proc. Asiat. Soc. Beng.* (N. Sr.) *2:* 385.

GORHAM, S.W. (1974): Checklist of World Amphibians up to January 1, 1970. The New Brunswick Museum, Saint John, N.B.

INGER, R.F. & DUTTA, S.K. (1987): An overview of the Amphibian fauna of India. *J. Bombay nat. Hist. Soc. 83 (Suppl.):* 135-146.

WOLF, S. (1936): Revision der Untergattung *Rhacophorus* (ausschliesslich der Madagaskar-Formen). *Bull. Raffles Mus. 12:* 137-217.

NOTES ON ACCEPTED SIGHT RECORDS OF BIRDS IN SRI LANKA[1]

THILO HOFFMANN[2]

In connection with my notes on some Sri Lankan birds (Hoffmann 1989) as listed by Ripley (1982), Dr Ripley had requested additional information in regard to the various sight records mentioned in the paper. Out of 81 species treated there, 16 are documented by sight records only. In view of possible wider interest the additional explanatory details are embodied in the present contribution which may be regarded as a supplement to the earlier paper. Also included here are 3 species in respect of which recent sight records appear more relevant than old specimens. Numbers and names are again identical with those of Ripley (1982).

All new records which are based on sightings only, including those listed by Phillips (1978), have been carefully scrutinised by the Ceylon Bird Club Rarities Committee. It has become almost impossible to collect bird specimens in Sri Lanka, and it would be unreasonable to exclude all sight records as such. The Committee took into account three main aspects: the quality and details of the description, the likelihood of the species occurring in Sri Lanka and the standing and reliability of the observer. Details in respect of the 19 species are as follows:

63. **White stork** *Ciconia ciconia*

This unmistakable bird has been sighted several times in the last century and again since the middle of this century by reliable observers (CBCN)[3].

153. **Longlegged buzzard** *Buteo rufinus*

On 26 January 1988 Ben King of the American Museum of Natural History, Bird Department, together with James and Robert Clements, identified a longlegged buzzard, probably a first-year bird, at Horton Plains National Park (elevation approximately 2134 m). A careful description was supplied.

[1]Accepted June 1989.
[2]Ceylon Bird Club, P.O. Box 11, Colombo, Sri Lanka.
[3]Ceylon Bird Club Notes (monthly since 1944).

376. **Caspian plover** *Charadrius asiaticus asiaticus*

One specimen collected by Phillips in 1951; next seen 1960. In recent years frequent, almost regular, winter sightings in Bundala-Hambantota area, three in 1985, one in 1986, seven in 1987, all by reliable Bird Club members.

378. **Ringed plover** *Charadrius hiaticula tundrae*

Only two sightings before 1973. Since then mainly single birds are seen almost every winter in various parts of the dry zone (e.g. Bundala) by very reliable Bird Club members such as T.S.U. De Zylva, John and Judy Banks, and also by myself. There can be no doubt. Most of the birds have been seen in the Bundala Sanctuary, around Hambantota, a few in the Mannar area, one or two in Yala National Park and Wilpattu National Park.

403. **Asian dowitcher** *Limnodromus semipalmatus*

One bird noticed by C. Brewster of Derry, Northern Ireland, at Karagan Lewaya near Hambantota on 22 July 1982, first together with some blacktailed godwits *Limosa limosa*, then among a party of common redshanks *Tringa totanus totanus*. He suspected the Asian dowitcher which was confirmed as most likely by Dave Allan on the basis of Brewster's notes. As small numbers of this species are known to visit eastern India and Bangladesh, a stray specimen could well reach Sri Lanka.

413. **Great or eastern knot** *Calidris tenuirostris*

First reported by Ben King from Mannar when one was seen amongst a flock of knots on 27 February 1981. King gave a detailed description. In February 1983 A. Mac Greham and three others saw several great knots in a flock of knots at Mannar and they too supplied careful descriptions. The knot *Calidris canutus canutus* too is a rare winter vagrant to the northern coasts of Sri Lanka.

423. **Spoonbilled sandpiper** *Eurynorhynchus pygmeus*

First reported by Ben King from Bundala on 2 March 1978.

425a. **Buffbreasted sandpiper** *Tryngites subruficollis*

First bird obtained by T.S.U. De Zylva on 5 March 1960. Subsequently also seen by J.C. Sinclair of Durban (S.A.) at Trincomalee in November 1974 and again by T.S.U. De Zylva at Embilikala Kalapuwa in the Bundala Sanctuary on 19 January 1985, when good photographs of the bird were taken. A Nearctic species which one would not readily expect in Sri Lanka (no records from Indian subcontinent), but the evidence is indisputable.

427. **Rednecked phalarope** *Phalaropus lobatus*

The first sighting in the Jaffna area by G.M. Henry in 1944 remained the sole record till the early '80s. Since then small flocks (up to six) are regularly seen every winter in the Bundala, Hambantota and Kalametiya area by John and Judy Banks and others.

447. **Pomatorhine skua** *Stercorarius pomarinus*

Single specimen from Colombo in 1912. Sight record 1954 in Hambantota. Then in 1978 several were identified by van den Berg *et al.* (1982) accompanying the mass movement of bridled terns *Sterna anaethetus* along the coast at Colombo. As this migration is an annual event, this skua is probably also a regular visitor to the Sri Lankan west coast.

455. **Blackheaded gull** *Larus ridibundus*

This species was first reported by J.C. Sinclair from Nilaveli (east coast) in November 1974. In December 1976 P.A. Dukes saw one at Arugam Bay, in February 1981 Ben King and party noted one at Talaimannar, and on 8 March 1978 one was seen by Robert Fleming, Jr. at Yala. In flight it can be quite readily distinguished from the brownheaded gull *Larus brunicephalus* with which it might be confused, but it may be easily overlooked by local bird watchers (CBCN).

456. **Slenderbilled gull** *Larus genei*

Seen on 2 September 1978 by Berg (1982) and two others along the causeway at Mannar. This remains the only record.

480. **Sandwich tern** *Sterna sandvicensis sandvicensis*

No specimen but a number of reliable sight records and one ring recovery without specimen (Hoffmann 1987).

910. **Sand martin** *Riparia riparia*

First sight record in January 1976 from Anuradhapura. Subsequently seen on telegraph wires near Hambantota in February 1981, and since then almost annually by various bird watchers and visiting ornithologists from U.K. and U.S.A., some of whom also have obtained photographs. All recent sightings of up to 10 birds together (usually with eastern swallows, *Hirundo rustica guttruralis*) have been in the extreme south from Kalametiya through Hambantota to Bundala.

933. **Grey shrike** *Lanius excubitor lahtora*

First reliable sight record in 1940 near Kekirawa, second in 1974 near Murunkan. Since then several reliable observations, at Yala (1986) and in the Hills (Hantane 1985, Haputale 1987).

988. **Greyheaded myna** *Sturnus malabaricus blythii*

A small flock of 11 birds noted in January 1984 at Anuradhapura by B.A. Dukes, a British ornithologist. Dukes and others saw the birds again in subsequent years (1985 and 1986) at the same place, and five birds were noted in the south at Kalametiya (1985) in a very large assembly of brahminy mynas *Sturnus pagodarum* and rosy pastors *Sturnus roseus*, and in Yala. In 1986 and 1987 several immatures were noted by Dukes in the flock at Anuradhapura, and it is very likely that the species is now a breeding resident in Sri Lanka, in small numbers.

1710. **Desert wheatear** *Oenanthe deserti*

Seen by R.W. Lekkerkerk of Holland on 13 February 1986 at Bundala. He supplied a very careful and detailed description which does not leave room for doubt. The only record so far.

1852. **Indian tree pipit**

Anthus hodgsoni hodgsoni

A flock reported in January 1982 by Robert Fleming, Jr. at Anuradhapura. Subsequently two and one seen in the Wilpattu National Park.

1891. **Large pied wagtail**

Motacilla maderaspatensis

One ancient specimen from Jaffna is recorded (Phillips 1978). First sight record November 1976 by P.B. Karunaratne from Mahaweli riverbed near Kandy; seen in same place in the following year, also by other observers, and again in December 1980 and January 1981. In 1983 two birds were seen on Delft Island, and in January 1984 one at Punkudutivu off Jaffna. I have seen three of these birds and feel that the species might be breeding on northern islands.

Since about 1978 there have been discoveries of new species for Sri Lanka, mainly winter migrants, almost every year, chiefly by visiting ornithologists. Due to the unsettled conditions in the country during recent years, such visits have sharply declined, and so have new sightings. The expected revival of tourism will doubtless produce further exciting discoveries in the years to come.

References

Hoffmann, T. (1987): The Sandwich Tern (*Sterna sandvicensis*) in Sri Lanka. *J. Bombay nat. Hist. Soc. 84 (2):* 440-442.

Hoffmann, T.W. (1989): Notes on the status and distribution of some birds in Sri Lanka *J. Bombay nat. Hist. Soc. 86 (1):* 7-16.

Phillips, W.W.A. (1978): Annotated Checklist of the Birds of Ceylon. Colombo.

Ripley, S. D. (1982): A Synopsis of the Birds of India and Pakistan, together with those of Nepal, Bhutan, Bangladesh and Sri Lanka. Bombay Natural History Society, Bombay.

Van den Berg, A. B. *et al.* (1982): Mass movement of Bridled Terns (*Sterna anaethetus*) and Wilson's Petrels (*Oceanites oceanicus*) off Colombo, Sri Lanka. *Ardea 70:* 81.

Van den Berg, A.B *et al.* (1982): First record of Slender-billed Gull (*Larus genei*) in Sri Lanka. *Ardea 70:* 82.

Wijesinghe, D.P. (1989): List of Sri Lanka Bird Species. *CBCN: 17a.*

POPULATION DYNAMICS OF HOUSE SHREW *SUNCUS MURINUS* IN RICE AND WHEAT FIELDS IN CENTRAL PUNJAB, PAKISTAN [1]

ABDUL RAUF KHOKHAR[2]

Population dynamics of the house shrew *Suncus murinus* in the wild in Pakistan is presented. Rice and wheat fields were kill trapped bimonthly from August 1977 to October 1978. There were significant variations in body weight, head and body length between specimens collected not only from different agro-ecological zones but also from the same area. Overall sex ratio of males and females did not deviate significantly from equality. However, males significantly outnumbered females in wet cropland of rice. Insect diet and reproduction greatly influenced the movements and density of shrews in rice and wheat fields. Pregnancy rate remained low in rice fields and high in wheat fields. Breeding stopped in winter. Litter size averaged 4.17 ± 0.38 (range = 2-6).

INTRODUCTION

The house shrew *Suncus murinus* is a well known, small mammal with a wide distribution (Roberts 1977, Brooks *et al.* 1980). The significance of this species has only recently been recognised from the health point of view because of its reported association with plague in urban areas of Burma, Vietnam and Taiwan (Brooks *et al.* 1980).

The information presented here on shrews was collected incidentally during a study on the biology of rodents of rice and wheat fields.

METHODS

The study was undertaken in Sheikhupura district (31°47′ N, 74°15′ E) along the Lahore-Sheikhupura road, 16-26 km west of Lahore. Data were gathered on shrews collected through snap traps baited with *chapati* (wheat flour pancake) and set in pairs 10-15 paces apart with 50 traps per trap line along the edge, 2-4 m into the crop fields. Two or four trap lines were operated simultaneously.

Rice crop is transplanted from nursery beds in June-July and harvested in October-November. Rice fields after harvest usually remain unploughed with stubble and many scattered piles of sheaves until December, when the fields are prepared for the wheat crop. Wheat is sown in November-December and harvested in April-May. July, August and September are the monsoon months.

Trapping was undertaken every two months from August 1977 to October 1978 in the regular study areas. Traps were set in the evening and checked in the morning typically for four consecutive days. New farms were selected for each bimonthly sample except August and October, which were sampled twice in 1977 and 1978. The yearwise sample were not large enough to permit comparison. Data for two years were pooled in the analysis.

Collection: Animals were collected from three trapping programmes: 1. A regular bimonthly trapping. 2. A kill trap survey of Punjab rice fields conducted by the personnel of Vertebrate Pest Control Laboratory in August 1977. 3. Punjab rice rat control trials conducted by the staff of the VPCL in 1977. Data gathered only from regular trapping sites were included in the determination of trap success, while the information on reproduction and diet was based on the animals received from other sources as well.

The trap success (Number of shrews x 100) ÷ (Number of trap nights) was used as an index of density. The body weight (BW), head and body length (HBL) were recorded only for a part of the collection. Shrews were sexed, weighed, measured and dissected within an hour after collection. Pesola spring balance was used for measuring BW. Reproductive conditions such as

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[2]Vertebrate Pest Control Laboratory, University Campus, Pest Management Research Centre, Pakistan Agricultural Research Council, P.O. Box 8401, Karachi 32, Pakistan.

lactation, embryo count, scar count, nulliparous or estrous condition were noted in all females trapped. In males, testes were observed for spermatogenic tubules in the cauda epididymis for fertility. Stomach contents of the shrews were microscopically analysed following Fulk *et al.* (1981).

Results

Sexual dimorphism: Table 1 shows HBL and BW of *S. murinus*. There was a significant difference in BW in all body lengths exceeding 129 mm ($P < 0.05$). Males predominated in the largest length classes.

Males: Rodent criteria of the position of testes as scrotal or abdominal could not be used to distinguish mature males from the immature ones.

Testes in *S. murinus* are retained permanently in the posterior position of coelomic cavity in a shallow pouch called cremaster sac (Deshpande 1959). They do not descend into a scrotum in fertile males as generally is the case in rodents. Male maturity, therefore, could only be distinguished internally by the presence or absence of spermatogenic tubules in the cauda epididymis. Moreover, testes in mature males were somewhat greenish in colour while pale in immature ones.

Overall, males had an average BW of 52.6 ± 1.26 (SE) g (range=28-82) and HBL 138.1 ± 1.5 (SE) mm (range = 101-175 mm). The average weight of mature males (with visible tubules) was 57.3 ± 1.3 (SE) g (range = 38-78) and HBL 143.2 ± 1.5 (SE) mm (range = 120-161). The average BW of immature males was 42.4 ± 2.8 (SE) g (range = 15-58) and HBL 132.4 ± 2.5 (SE) mm (range = 115-154). Mature males weighed significantly more than immature ones ($t = 4.83$; df = 72; $P< 0.001$). The HBL of mature males was also significantly greater than that of immature ones ($t = 3.71$; df = 69; $P< 0.001$).

Females: Rodent criteria of opening of vaginal orifice could not be used for separating mature female shrews from immature ones because the orifice is concealed in the cloaca. The attainment of reproductive maturity was judged only by examining the state of uterus (pregnant, scars or estrous).

The average BW of females was 37.4 ± 0.9 (SE) g (range = 24-58) and HBL 122.8 ± 1.57 (SE) mm (range = 89-150). The average BW of mature females was 41.4 ± 1.49 (SE) g (range = 24-58 and HBL 129.1 ± 2.58 (SE) mm (range = 107-138).

The average BW of mature but non pregnant females was 43.2 ± 1.79 (SE) g (range = 24-54) and HBL 134.3 ± 3.09 (SE) mm (range = 109-154). The average BW of immature females was 34.0 ± 1.15 (SE) g (range = 24-46) and HBL 121.9 ± 2.04 (SE) mm (range = 109-141). The average BW of mature females was significantly greater than that of immature ones ($t = 4.32$; df = 57; $P<0.001$). The average HBL of mature females was also significantly greater than that of immature ones ($t = 3.35$; df = 55; $P < 0.005$).

Density: During the rice season, the shrew density was low in August but increased as harvest ap-

Table 1

Mean body weight and body length in *Suncus murinus* from Punjab

Head & body length classes	Body weight (g)* Males	Females	Probability of difference
89–98	–	(1) 30.0	–
99–108	(1) 38.0	(4) 30± 4.0	–
109–118	(2) 40 ± 10	(15) 34.4± 5.9	N S
119–128	(13)42.4 ± 9.3	(20) 37.9 ± 6.4	N S
129–138	(24)48.8 ± 10.2	(9) 44.1± 4.5	P < 0.05
139–148	(18) 56.3 ± 5.2	(3) 47.3 ± 7.7	P < 0.05
149–158	(10) 65 ± 10.9	(3) 45.5± 8.5	P < 0.05
159–168	(3) 68 ± 4.2	–	–

*Body weights were taken only of those specimens whose measurements were also taken.
Numbers in parentheses indicate number of specimens examined.

TABLE 2
SEX RATIOS OF *Suncus murinus* IN WET AND DRY CROPLAND

Sex	Wet	Dry	Total
Male	56	26	82
Female	35	34	69
Total	91	60	151

TABLE 3
TRAP SUCCESS AND REPRODUCTIVE PATTERN OF *Suncus murinus* IN RICE AND WHEAT FIELDS

Month	Crop	Trap nights	Trap success	Males % tubules visible	Females % pregnant	Mean litter size
August	Rice (vegetative)	690	1.3	81 (16)	37.5 (8)	3.7
October	Rice (harvest)	1169	3.2	62 (34)	28.6 (21)	4.0
December	Rice (unploughed fields)	750	6.8	–	–	–
February	Wheat (flowering)	712	0.7	0 (2)	0 (3)	–
April	Wheat (harvest)	699	0.4	100 (1)	100 (2)	4.0
June	Wheat (fallow fields)	740	0.8	75 (74)	100 (2)	5.5

Sample sizes are given in parentheses.

proached (Table 3). The density was highest in the unploughed post harvest rice fields in December when the fields were devoid of any vegetational cover except rice stubble. After a peak in December, the shrew density again declined sharply during the flowering stage of wheat (February) and remained low in the harvest and post harvest stage of the crop, i.e. April and June (hot months).

Diet: The diet of shrews contained 4% rice and 16% wheat during the months of rice and wheat ripening Insects accounted for over 70% of the diet in all months except February and April, when insect consumption fell to 63 and 44%, respectively.

REPRODUCTION

Sex ratio: The ratio of males to females was 1 : 0.8 which did not deviate significantly from unity $\chi^2 = 1.1$; $P < 0.25$). Males, however, significantly outnumbered females (Table 2) in wet fields of rice crop, χ^2 4.84; P<05).

Male fertility: The number of fertile males remained high in all months, though at lower proportions during October and February when the overall pregnancy rates were also low (Table 3).

Pregnancy rates: Pregnancy rates as determined from embryo count were low from August to October in the irrigated rice fields and high from April to June in the dry wheat fields (Fig.1, Table 3) with no breeding in cold months (February). Data could not be recorded in December. Anyhow, Beg *et al.* (1986) report that *S. murinus* ceases to breed in the Punjab in the cold months of December and January.

Litter size: Litter size averaged 4.17 ± 0.38 (range = 2-6).

TABLE 4
WEIGHTS AND MEASUREMENTS OF *Suncus murinus* (mean ± SE)
AT FAISALABAD* AND SHEIKHUPURA

Type	N	Weight (g)	Body length
Males			
Faisalabad (F)	26	57.5 ± 1.99[a]	148 ± 1.82 [b]
Sheikhupura (S)	82	52.6 ± 1.26	138.1 ± 1.52
Females			
Faisalabad (F)	50	41.3 ± 1.54[a]	132 ± 1.68[b]
Sheikhupura (S)	69	37.5 ± 0.9	122.8 ± 1.57

a = Significantly greater than S at P <0.025 by Student's t-test. b = Significantly greater than S at P <001 by Student's t-test.
* Faisalabad data were taken from Beg *et al.* (1986).

DISCUSSION

Extreme variations in adult weight of this species from various geographic localities have been reported by several authors (Brooks *et al.* 1980, Rana and Prakash 1979, Hasler *et al.* 1977, Louch *et al.* 1966, Barbehenn 1962, Harrison 1955).

The heaviest *S. murinus* were reported from Calcutta by Louch *et al.* (1966) who found that male (N=75) and female (N = 92) shrews averaged 105.6 g and 67.6 g respectively. The smallest *S. murinus* was recorded from Guam by Barbehenn (1962), who noted the average weight of males to be 30 g and that of females 21 g. Dryden's (1968) figure is still lower — 1.8 g. Harrison (1955) found weights of 55 g and 45 g for male and female Malaysian *S. murinus*, respectively. The weights of male and female shrews in the present study area are quite close to those of Malaysian shrews but considerably less than those of Calcutta.

Uptill now several workers have recorded significant variations in adult BW and HBL of *S. murinus* trapped from different geographical localities. However, comparison of data from Sheikhupura and Faisalabad districts of Punjab collected respectively during the present study and by Beg *et al.* (1986) suggested that even shrews living in the same locality showed significant variations in BW and HBL (Table 4). The BW and HBL of male shrews in Faisalabad (F) were significantly greater than those of Sheikhupura (S) male shrews ($t = 2.07$; $df = 142$; $P < 0.025$ and $t = 4.15$; $df = 142$; $P < 0.001$, respectively). Similarly, F-females were also significantly heavier and longer than S-females ($t = 2.13$; $df = 117$; $P < 0.025$ and $t = 4.00$; $df = 117$; $P < 0.001$, respectively).

Various parameters of shrew population in rice and wheat fields were influenced by environmental changes in the surrounding habitat. Low shrew density in the flooded rice fields in August in spite of high (100%) pregnancy rates in the preceding dry months and abundant (71.9%) insect diet in this month could be related to the possibility that excessive water in rice fields was unfavourable for the survival of shrews.

The peak density in the cold month (December) in fallow and uncovered dry rice fields seemed to be linked with the immigration of shrews from the surrounding area and not with the recruitment of young as the reproductive rate was low (28.6%) in the previous months (Table 3)

This seemed possible as the insects which are one of major determinants of shrew density (Smiet *et al.* 1980) were the main (81.4%) food items in the diet. In Punjab, the larvae of rice insect pests generally overwinter in the stubble during cold months (Choudhry *et al.* 1983). Therefore, immigration of shrews into rice fields might have been due to the presence of these larvae.

After rice harvest harvest, the crash in the shrew density in February, which persisted up to April in wheat fields, could be related to winter quiescence in reproduction in the current and preceding months. Moreover, the insect diet also fell (63 and 44%) during these months. The second peak (though small) in fallow wheat fields

TABLE 5
REPRODUCTIVE PROFILE OF *Suncus murinus* AT SIX PLACES

Place/Author	Weight of Female (g)	Litter size	Breeding
Guam Barbehen (1962)	21.0	2.1 ± 0.10	Throughout the year
Malaysia Harrison (1955)	45.0	2.7 ± 0.14	Throughout the year
Rangoon Brooks *et al.* (1980)	41.6	2.99 ± 1.21	Throughout the year
Calcutta Louch *et al.* (1966)	67.7	3.8 ± 0.28	Throughout the year
Rajasthan desert Rana & Prakash (1979)	23.5	4.71 ± 0.23	September to March No breeding from October to February
Punjab Present study	37.5	4.17 ± 0.39	April to October. No breeding in winter (February)

in June followed the month (April) of high (100%) reproduction. Moreover, high (95%) frequency of insect diet available in June also seemed to be responsible for this peak.

Although data on pregnancy rates in *S. murinus* is small, a clear cut reproductive pattern did emerge from this study. The breeding data presented here are not incompatible with that observed in *S. murinus* in Rangoon, Calcutta, Guam and Malaysia (Brooks *et al.* 1980, Louch *et al.* 1966, Barbehenn, 1962, Harrison 1955). At all these places the peak in reproductive activity occurred in the dry season and declined during rainy season. In Punjab, the peak in pregnancies also occurred in dry wheat fields from April through June and then reduced in inundated rice fields (with water overflowing the bunds) in August and remained so up to October. This low breeding activity suggested that rice field environments adversely effect breeding in this species. Conversely, highest breeding was recorded in *S. murinus* during monsoon in the Rajasthan desert by Rana and Prakash (1979) and in indoor populations by Brooks *et al.* (1980) and Beg *et al.* (1986). At all these places the negative effect of rainfall on breeding obviously did not exist.

Increase in litter size has been reported to occur with increase in body weight in *Suncus* (Table 5). This criteria, however, does not hold good with the shrew population in Rajasthan and Punjab, where females, though lighter (23.5 and 37.5 g) than at other places, still produce significantly larger litters of 4.71 ± 1.23 and 4.17 ± 0.39 respectively. The female at these places stops reproduction during winter months as against those which continue breeding throughout the year. The larger litter size in Punjab and Rajasthan population in a way may be a compensation for winter cessation of breeding so as to maintain a higher yearly turnover rate of the population (Rana and Prakash 1979, Beg *et al.* 1986).

REFERENCES

BARBEHENN, K.R. (1962): The house shrews on Guam. *In:* Pacific Island Rat Ecology. Ed. T.I. Storer, Bishop Mus. pp. 225, 247-256.

BEG, M.A., KAUSAR, S., HASSAN, M.M. & KHAN, A.A. (1986): Some demographic and reproductive parameters of the house shrews in Punjab, Pakistan. *Pak. J. Zool. 18 (2):* 201-208.

BROOKS, J.E., HTUN, P.T., WALTON, D.W., NAING, H.& TUN, M.M. (1980): Reproductive biology of *Suncus murinus* L. in Rangoon, Burma. *Z. Saugetierkunde 45:* 12-22.

Choudhry, N.A., Razzaq, M.A. & Masood, I. (1983): Population dynamics of rice stem borers on light traps in rice growing areas of Punjab. Proc. Fourth National Seminar on Rice Research and Production, 1983. Pakistan Agricultural Research Council, Islamabad. pp. 268-273.

Deshpande, K.S. (1959): Morphology of the male reproductive system in the shrew, *Suncus murinus* Linn. (Insectivora, Soricidae). *Bull. Zool. Soc. Coll. Sci.* (Nagpur) *2:* 1-9.

Dryden, G.L. (1968): Growth and development of *Suncus murinus* in captivity in Guam. *J. Mammology 49:* 51-61.

Fulk, G.W., Lathiya, S.B. & Khokhar, A.R. (1981): Rice rats of lower Sind: abundance, reproduction and diet. *J. Zool. London. 193:* 370-390.

Harrison, J.I. (1955): Data on the reproduction of some Malayan mammals. *Proc. Zool Soc. London 125:* 445-460.

Hasler, M.J., Hasler, J.F. & Nalbandov, A.V. (1977): Comparative breeding biology of musk shrew *Suncus murinus* from Guam and Madagascar. *J. Mammology 58:* 285-290.

Louch, C.D., Ghosh, A.K. & Pal, B.C. (1966): Seasonal changes in weight and reproductive activity of *Suncus murinus* in West Bengal, India. *J. Mammology 47: 73-78.*

Rana, B.D. & Prakash, I. (1979): Reproductive biology and population structure of the house shrew, *Suncus murinus sindensis* in Western Rajasthan. *Z. Saugetierkunde 44:* 333-343.

Roberts, T.J. (1977): The mammals of Pakistan. Ernest Benn. Limited, London.

Smiet, A.C., Fulk, G.W., & Lathiya, S.B. (1980): Rodent ecology in sugarcane in lower Sind, Pakistan. *Acta. Theriol. 25(8):* 79-81.

NOTEWORTHY PLANT INVASIONS IN THE FLORA OF WESTERN GHATS OF MAHARASHTRA[1]

VINAYA S. GHATE[2]

Plant invasion is the successive and aggressive establishment of exotic plant species in the flora of a region. These invading species by their prolific adaptability replace the elements of the original ecosystem gradually and dominate the area. 40 important invasions in the flora of Western Ghats of Maharashtra are described here. Details regarding country of origin, period of introduction, mode and place of introduction and habitats invaded by the species, as well as control measures, if any, are discussed.

INTRODUCTION

Exotic species following immigration or introduction get acclimatized in the original flora of an area. Some introduced species by their prolific adaptability supported by various natural and man-made agencies, spread very fast, invade large areas and become obnoxious weeds.

Studies on plant invasions are meagre although exotic flora of various botanical regions have been worked out by various scientists like Bruhl (1908), Kashyap (1922-23), Jouget (1928), Biswas (1934, 1941), Srivastava (1954, 1964), Maheshwari (1960), Jain (1963), Santapau (1964), Harlan and deWet (1965), Matthew (1969), Ramaswami *et al.* (1973), Maheshwari and Paul (1975), Haridasan *et al.* (1981), Maiti and Guha Bakshi (1981) and Mukherjee (1981).

Considering the hilly areas of western Maharashtra, studies on exotic flora in general and plant invasions in particular are lacking, except for stray references in floras like Cooke (1903-1908), Santapau (1953, 1957) and many others. An attempt, therefore, was made to explore the region under study for evaluating exotic weed flora. The paper includes observations on 40 important plant invasions in areas of the western Ghats of Maharashtra.

METHODOLOGY

In routine botanical tours in the area under study, special efforts were made to record invasive plant species in various habitats like protected forest areas, disturbed forest areas, waste lands, water reservoirs and surrounding wetlands, cultivated fields and parks and gardens. Critical notes on life cycle, growth, associated flora and extent of spread of individual species were made in the field. The notes were supplemented by herbarium studies and literature survey.

The results of these studies are compiled in tabular form. The species enumerated in Table 1 are classified under two main heads, namely (i) species introduced purposely but which have run wild and (ii) species which arrived accidentally and have became established. Notes regarding country of origin, period of introduction, mode and place of introduction, and habitat invaded have been included in Table 1.

DISCUSSION

The process of introduction and subsequent naturalisation of foreign plants was initiated some 450 years back with Portuguese settlers in India. In the course of their settlement and stay in Goa, they brought a good number of economically valuable plants from different parts of the world and introduced them in various corners of the country. A large number of other species were unwittingly transported into the country along with the deliberate introductions, and subsequently became included in the flora.

The peculiar terrain of western Maharashtra coupled with varied climatic conditions and heterogeneous vegetational elements provided habitat for these exotic plants. The survival, growth and spread of these introductions was variable depending upon suitability of habitat and

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TABLE 1
ENUMERATION OF SPECIES

A) SPECIES DELIBERATELY INTRODUCED BUT NOW WIDESPREAD

Sl. No.	Species	Nativity/probable period of introduction	Mode of introduction and habitats invaded
1.	*Datura metel* L.	Tropical America/Before 18th century	Introduced probably for its medicinal use; spread along waste land. Recorded as luxuriant undergrowth in *Casuarina* plantations along the coast.
2.	*D. quercifolia* H.B. & K.	America/Early 20th century, 1954	Recorded in 1954. Spreading slowly in waste land.
3.	*D. stramonium* L.	America/Early 20th century, 1957	Introduced for its medicinal utility. Recorded from 1957, spreading in waste land.
4.	*Eichhornia crassipes* Solms	Brazil/17th century	Introduced for its ornamental flowers. Now a pest in every aquatic habitat.
5.	*Ipomoea carnea* Jacq.	South America/Early 20th century, 1921	First reported in south India, as growing in gardens. Spreading very fast, has occupied salt marshes, marshy areas and waste lands.
6.	*I. nil* (I.) Roth	Tropical America/A century ago	Introduced for its ornamental flowers. Now invading open forest margins, waste land.
7.	*Jatropha curcas* L.	Tropical America/Before 19th century	Introduced as a fast growing species for afforestation in arid zones. Spreading slowly in open areas.
8.	*Lantana camara* L.	Central America/Early 18th century, 1809 in Calcutta Garden, 1824 in other areas.	Introduced as ornamental plant for its showy flowers. Widespread in almost all habitats. Major invasion in *Tectona* forests
9.	*Leucaena leucocephala* de Wit.	Mexico/ A century ago	Introduced as a fast growing species for afforestation. Commonly adapted in various plantations. Now spreading fast in all habitats.
10.	*Opuntia dillenii* How.	South America/18th century	Introduced for cochineal industry. Spread everywhere very fast and became a serious pest. Nowadays, controlled growth at a few places. It was controlled biologically.
11.	*O. elator* Mill.	Mexico/18th century	It was introduced, spread and controlled similarly to *O. dillenii.*
12.	*Pilea microphylla* (L.) Liebm.	South America	Introduced as foliage ornamental plant. Spreading as pot weed in parks and gardens.
13.	*Prosopis chilensis* DC.	Mexico/1877	Introduced as a fast growing species for afforestation programmes in arid zones. Now occupies large areas, particularly open or disturbed forest areas and waste lands.
14.	*Ricinus communis* L.	Tropical Africa/Early period	Introduced probably for its medicinal utility. Invaded habitats like open barren areas and waste places, particularly near habitations.

Sl. No.	Species	Nativity/probable period of introduction	Mode of introduction and habitats invaded
15.	*Tridax procumbens* L.	Mexico/1830	Said to have been introduced as ornamental species. Spread as garden escapee and naturalised. Now found everywhere.
16.	*Xanthium strumarium* L.	Mexico/Before 17th century	Reportedly introduced as a source of medicine. Growing in every habitat type including cultivated fields.
B) ACCIDENTALLY INTRODUCED SPECIES:			
1.	*Acanthospermum hispidum* DC.	South America/Early 20th century	Introduced along with ballast and packing material of imported goods. Spread mainly along railway lines and thereafter invaded forest clearings and open waste land. Now occupies almost all habitats.
2.	*Ageratum conyzoides* L.	South America/Late 19th century	Introduced along with foreign packing material. Spread very fast through biotic factors and has occupied almost all habitats including cultivated fields.
3.	*Alternanthera pungens* HB. & K. .	Tropical America/Early 20th century, 1908	Introduced along with baggage and goats. Spread slowly and invaded habitats like open areas and road sides.
4.	*Argemone mexicana* L.	Central America/Earliest record of 1790	Very early introduction and spread. Invaded habitats like waste land, open forest areas, road sides. Commonly invades disturbed soils.
5.	*Cassia occidentalis* L.	South America/Before 18th century	Introduced along with foreign goods in very early period. Common element in dry regions along waste lands and barren areas.
6.	*Cassia tora* L.	South America/Early 17th century	Very common weed of every useful land due to its fast and gregarious growth.
7.	*C. uniflora* Mill.	West Indies and Tropical Africa/ Very recent in 1980	Introduction recent, spreading very fast. Replacing another obnoxious weed, *Parthenium* by its gregarious growth. Has invaded waste lands and canal sides.
8.	*Chloris barbata* Sw.	Tropical Africa/ Late 17th century	Two opinions about its introduction, one that it came by attachment to baggage and second, introduced as fodder grass. Has invaded all habitats including cultivated fields.
9.	*Croton bonplandianum* Baill.	South America/ 1897 – south India; 1962 – Maharashtra	Introduced with ballasts. Invading marshy habitats.
10.	*Elephantopus scaber* L.	America/Post Columbian period (Maheshwari and Paul 1975)	Widespread in disturbed forest areas, forest clearings and waste lands.
11.	*Eupatorium adenophorum* Spreng.	Mexico/Early 1900s	Probably introduced with ornamental plants. Has spread fast and now occupies habitats like road side open places and hilly areas.

Sl. No.	Species	Nativity/probable period of introduction	Mode of introduction and habitats invaded
12.	*Euphorbia heterophylla* L.	Tropical America/ 17th century	Introduced at a very early period. Invaded all habitats particularly cultivated fields and other cultivable lands.
13.	*Gomphrena celosioides* C. Mart.	South America/Early 20th century/1964	Although introduced recently in area under study, the spread is fast. Has mainly invaded cultivated lands.
14.	*Heliotropium indicum* L.	America/About 1500 AD	Introduced alongwith ballast for baggage. Very common along waste lands and open areas.
15.	*Ipomoea triloba* L.	Recently in 1954	Probably introduced with ornamental plants. Spreading in gardens and parks and also along roads, waste lands and open areas.
16.	*Lagascea mollis* Cav.	Mexico/Before 18th century	Naturalised species, has invaded almost all habitats including cultivated lands and forest areas.
17.	*Martynia diandra* Glox.	Mexico/ 1843	Naturalised species, spread by attachment of its hooked fruits to hair of goats and sheeps. Common on waste land, road sides and open areas.
18.	*Oxalis corniculata* L.	Europe/1931	Introduced along with ornamental plants. Invading parks, gardens and compounds. Commonly seen in lawns and greenhouses.
19.	*O. latifolia* Kunth	Mexico/19th century	Introduced with gardens ornamentals and has spread in parks and gardens. Also found in forest clearings.
20.	*Parthenium histerophorus* L.	West Indies/1956	Although introduced very recently, has spread widely and invaded habitats like cultivated fields, waste lands and forest clearings. Now an obnoxious weed in cultivated fields.
21	*Peperomia pellucida* (L.) H.B. & K.	Central America/19th century	Introduced probably with ornamental herbaceous species, now invading gardens, parks and household cultivated areas.
22.	*Physalis minima* L.	South America/Before 17th century	Has invaded wastelands, forest clearings and dry open areas. Spreads through cattle, birds and other biotic factors.
23.	*Portulaca oleracea* L.	Europe/Late 19th century	Introduced probably with vegetable seeds. Now growing in moist areas of cultivated lands and also open areas.
24.	*Synedrella vialis* L.	Mexico/1969	Recent introduction, probably with ornamental plants. Rapidly invading gardens, open places and even forest clearings and open areas.

adaptability of individual species, coupled with natural and man-made factors.

Species like *Datura metel*, *Eichhornia crassipes*, *Lantana camara*, *Leucaena leucocephala*, *Prosopis juliflora* and *Ricinus communis* were introduced deliberately for their utilitarian vir-

tues. These species, with their higher distribution potential, spread rapidly and now occupy various habitats including waste lands.

The highest distribution potential and prolific adaptability is shown by fast invading species like *Ageratum conyzoides*, *Cassia tora*, *Eichhornia crassipes*, *Euphorbia heterophylla*, *Gomphrena celosioides*, *Ipomoea carnea*, *Lagascea mollis*, *Lantana camara*, *Parthenium histerophorus* and *Prosopis juliflora*. Introduction of these species, particularly that of *Gomphrena celosioides*, *Ipomoea carnea*, *Leucaena leucocephala* and *Parthenium histerophorus* is very recent, in the late 20th century. The spread of these species, however, is very wide. Species like *Cassia uniflora* and *Synedrella vialis* have been reported to occur in the area over the last 5-7 years. They are also spreading very fast, invading new areas and forming pure stands.

Earlier introductions like *Acanthospermum hispidum*, *Argemone mexicana*, *Croton bonplandianum*, *Heliotropium indicum*, *Jatropha curcas*, *Physalis minima* and *Ricinus communis*, although they have spread to a greater extent in the area under study, do not grow in pure stands as do *Cassia uniflora*, *Eichhornia crassipes*, *Ipomoea carnea*, *Parthenium histerophorus* or *Synedrella vialis*.

This process of introduction is still active and will doubtless continue indefinitely for the needs of man. However, due care should be taken to avoid future problems that prolific invasions may pose.

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References

Biswas, K. (1934): Distribution of some of the common harmful exotic weeds established in the country. *Indian Forester 60:* 861-865.

Biswas, K.P. (1941): The role of foreign plants in the economic life of Bengal. *Sci. & Cult. 7:* 279-284.

Bruhl, P. (1908): Recent plant immigrants. *J. Asiat. Soc. Beng. (N.S.) 4 :* 603-656.

Cooke, T. (1903-1908): The Flora of Presidency of Bombay. Vols. 1-3. (1958 Reprint). Botanical Survey of India, Howrah.

Haridasan, K., Kumar, Y. & Rao, R.R. (1981): Enumeration of some important forest weeds of Meghalaya with special emphasis on their role and distribution. *J. Econ. Tax. Bot. 2* : 161-171.

Harlan, R.J. & De Wet, J.M.S. (1965): Some thoughts about weeds. *Econ. Bot. 19 (1):* 16-24.

Jain, S.K. (1963): Invasion of plants in arid regions of India. *Proc. Nat. Acad. Sci. India. Sect. B. 33(1):* 58-60.

Jouget, H. (1928): Weeds of Indian way side. *J. Bombay nat. Hist. Soc. 32:* 810-812.

Kashyap, S.R. (1922-23): Notes on some foreign weeds that have established themselves around Lahore. *J. Indian Bot. Soc. 3:* 68-71.

Maheshwari, J.K. (1960): Studies on naturalized flora of India. *Proc. Summer School in Botany (Darjeeling).* pp. 154-170.

Maheshwari, J.K. & Paul, S.R. (1975): The exotic flora of Ranchi. *J. Bombay nat. Hist. Soc. 72(1):* 158-188.

Maiti, G.G. & Guha Bakshi (1981): Invasion of exotic weeds in West Bengal since 1903: Dicotyledons and Monocotyledons. *J. Econ. Tax. Bot. 2:* 1-21.

Matthew, K.M. (1969): The exotic flora of Kodaikanal, Palni Hills. *Rec. Bot. Surv. India, 20(1):* 1-241.

Mukherjee, A.K. (1981): Distribution potentiality and plant introduction. *J. Econ. Tax. Bot. 2:* 277-229.

Ramaswami, S.V., Rao, R.R. & Bhaskar, V. (1973): Notes on adventive plants of Bangalore and Mysore Districts. *J. Mysore Univ. Sect. B 26:* 40-60.

Santapau, H. (1953): The Flora of Khandala on the Western Ghats of India. *Records of Botanical Survey of India16 (1):* 1-369.

Santapau, H. (1957): The Flora of Purandhar. Oxford Books and Stationery Co., New Delhi.

Santapau, H. (1964): These exotic weeds need watching. *Indian Farming 14(4):* 23.

Srivastava, J.G. (1954): Some recently introduced or newly recorded plants from Patna District and its neighbourhood. *J. Bombay nat. Hist. Soc. 53:* 659-660.

Srivastava, J.G. (1964): Some tropical American and African weeds that have invaded the State of Bihar. *J. Indian Bot. Soc. 43(1):* 102-112.

REHABILITATION OF SALTWATER CROCODILES *CROCODYLUS POROSUS* SCHNEIDER IN THE BHITARKANIKA WILDLIFE SANCTUARY, ORISSA[1]

S.K. KAR[2] AND H.R. BUSTARD[3]

This paper describes the rehabilitation of the second batch of 80 young captive reared salt water crocodiles *Crocodylus porosus* Schneider into Suhajora creek of Bhitarkanika Wildlife Sanctuary during the year 1978. Monitoring of the released crocodiles reveals that they migrated downward towards the mouth of the river.

INTRODUCTION

Kar and Bustard (1990) report results of the pilot release of 15 saltwater crocodiles *Crocodylus porosus* Schneider into the Bhitarkanika Wildlife Sanctuary in April-May 1977. This provides the background to the rationale of the 'rear and release' technique in which young crocodiles measuring 1.0-1.2 m, reared from wild-collected eggs and incubated in captivity are released back into the Sanctuary (Bustard 1974, 1975). The above cited paper also provides a brief description of the Sanctuary, the release and monitoring methodology.

Detailed monitoring was carried out at night at approximately monthly intervals using a spotlight or 5-celled torch for a period of 34 months.

The present paper describes the results of the release of 80 saltwater crocodiles into the Suhajora creek in the heart of the Bhitarkanika sanctuary. This release, like the pilot release which preceded it, forms part of the Government of Orissa's Conservation Project on the saltwater crocodile, operated by the State Forest Department. This project was initiated in 1975 as a result of a report of Bustard (1974). The Bhitarkanika Wildlife Sanctuary was declared in April 1975 by Government of Orissa and the Government of India, F.A.O./U.N.D.P. Project Crocodile Breeding and Management.

MATERIAL AND METHODS

Selection of release site: The release at Suhajora creek, a 6 km, blind-ended creek near Bhitarkanika island in the core of the sanctuary, was selected as an ideal crocodile habitat, free from disturbances of any kind. This creek is 5-6 km from the nearest human habitation. Creeks in the Sanctuary are either blind-ended, end naturally or have been bunded to reduce ingress of salt water to the landward side of the bund, which is under cultivation. The latter creeks have sluice gates and are not suitable for releases (Kar and Bustard 1981). Furthermore, these bunded creeks do not appear to have suitable nesting habitat for *Crocodylus porosus.*

Timing of release: 80 crocodiles were released into the upper third of this blind-ended creek, the middle third of the creek and the lower third in three batches on three consecutive days, 26, 27 and 28 February 1978. The number of crocodiles released into each sector was 30, 26 and 24, respectively.

Selection of crocodiles for release: The crocodiles for release were hatched in 1976 and in the size class of 1.0-1.2 m. Due to a paucity of males in this year-class, the released crocodiles comprised 78 females and two males.

Action taken at the release site prior to release: Suhajora creek had been studied over the preceding three years and the resident crocodile population was known. This comprised eight crocodiles: a pair of adults, the male 18-19′ (5.5-5.8 m), the female 11-12′ (3.4-3.7 m), one sub-adult 5′4" to 6′ 4" (1.6-2.1 m) and five juveniles of approximately 1.5 m. Three of these juveniles occupy the lower third of the creek and the other two the middle third. The adult pair move between the mouth and the middle of the creek.

The top third sector of Suhajora creek, being very narrow and very shallow at low tide, is only

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substantial at the time of the fortnightly high tide. The middle portion provides good crocodile habitat throughout the tide cycles including the lower portion which is wide and deep. Both these sectors of the creek provide ideal habitat for adult, sub-adult as well as juvenile crocodiles.

Release procedure: The crocodiles for release were tail scute clipped for subsequent recognition. The method adopted (Kar and Bustard 1990) permitted identification of sex and year of release. In the present instance, the second last scute in the double scute row was clipped, the scute on the left hand side in the case of females and the scute on the right hand side in the case of males. Crocodiles were transported in damp gunny bags from the Dangmal Rehabilitation Centre to Suhajora creek, a distance of 10 km by dinghy.

Results

Released crocodiles were regularly monitored in order to record data on their movement in the wild. A total of 24 monitoring visits were made between 30 March 78 and 30 December 1980. Details of the number of released crocodiles sighted and the number estimated to be present in each third of the creek are given in Table 1. This table shows a marked downward movement of crocodiles from the first census, which was carried out approximately one month after the release. There were also downward movement trends of those individuals released in the middle sector. Movement from the lower third was comparatively very slow as this habitat was preferred by the small, release sized crocodiles. This agrees with observations on the natural population (see discussion). Some data are available on individuals which moved down to the main Bhitarkanika river.

Released crocodiles gradually moved into the main Bhitarkanika river and from there into other creeks.

Observations

1. One released crocodile (a female) was caught by net on 18 September 1978, close to Khola village by the side of the saline embankment. It was badly injured by the village people and died the following day. The distance from the release site to the end of the Khola creek, the capture site, was about 20 km.

2. A second crocodile was sighted on 24 September 1980 in an unused pond, close to Khola creek inside the saline embankment while the tide level was touching the base of the embankment. The crocodile was identified as one of the released animals by the tail scute clipping. On 27 September 1980 the pond was searched but the crocodile had left either to Khola creek or some other place.

3. Five of the 1978 released crocodiles settled in the Mainsamada creek, increasing the juvenile population to seven in the main creek.

The distance from Suhajora mouth to Mainsamada mouth is about 2 km and 6.5 km to the end of Mainsamada creek. Crocodiles were sighted in this stretch and these had spaced themselves along the creek.

After a month, less than one third (9 of 30) of the crocodiles were seen in the upper one third of the creek and it is estimated that half the crocodiles had moved from this area of the creek. The highest density of crocodiles observed was in the middle third (20 crocodiles) and lower third (22 crocodiles). Numbers had presumably increased by migration downstream from the upper third. This probability is strengthened by the high estimates (131% and 150%) for the middle and lower third of the creek, respectively.

Hence all released crocodiles were still in the creek after the first month from the date of release and were moving down the creek. After two months, the number left in the top one third was 5 (actually sighted) and 8 (27%) estimated. The number then seen in the middle one third had almost halved to 12 individuals and the estimated population dropped from 33 (131%) to 20(80%). This indicates that the many crocodiles moving out of the upper third had not established themselves in the middle third but continued migrating down the creek along with some of those released, in the middle portion. The number in the lower third of the creek reached its maximum, as 26

individuals actually observed (108%) as against only 24 released, giving an estimate of 43 (169%). That crocodiles were now moving out of this creek is apparent from the falling trend in the total number observed and estimated. These figures fell from 51 to 43 and 85 to 70 crocodiles, respectively.

In the third month, only one crocodile still inhabited the upper third of the creek. In all the subsequent survey visits, this area of the creek was completely devoid of released crocodiles. The numbers in the middle and lower third fell slightly, a trend which continued in the succeeding months although this trend was much more marked in the middle third compared to the lower third of the creek. Table 1 indicates that 11 months after release, the number in the lower third still exceeded 100% of those released (estimate 116%) whereas at this time the estimate for the middle third had fallen to 2 individuals (8%). The figure for the middle third remained at one to two sightings with an estimated population of two to three individuals for the remainder of the study.

Discussion

The difference in the time period for migration between sectors for half the released animals to have moved out, partly reflects the addition of animals moving downstream through the lower sectors from the sectors immediately above it. Hence, as stated, the upper one third sector estimate had halved after one month and was virtually at zero (estimate 2 individuals) after three months. For the middle one third sector, it took 7 months to halve and 10 months to reach virtual zero (estimate 2 animals). For the lower one third the estimate remained at 95% after one year. It reached an estimated low of three animals after 20 months, was back at five after 24 months and reverted to three after 25 months and remained so for the rest of the survey period (a total of 34 months). The above cannot be a full explanation however, for the following reasons:

1. When the number in the upper one third sector fell to virtually zero, there were no more animals available to move down into the middle portion.

2. When the middle third reached zero in July 1979, the lower third estimate stood at 116%. It took a further four months to reach 50% and from that level reached its 'base line' level of two observed (three estimated) animals in October 1979 after another five months. The lower one third, however, fell from 116% to its baseline level in nine months, as fast or faster than the middle sector.

The rate of 'loss' of animals from the creek is a slow one, clearly as a result of the gradual movement down the creek rather than an active movement out of the creek to a new locality following release.

The data in Table 1 indicates that the annual monsoonal floods were not responsible for the observed movements. The movement out of the top one third sector of the creek occurred in the summer. After the monsoon, the middle sector stood at 57% (estimate) whereas at the very end of May, immediately prior to the monsoon which commences in early June, it had stood at 69%. Similarly the lower one third sector stood at 150% immediately prior to the onset of the monsoon and had an identical figure three months after the end of the monsoon. Immediately after the monsoon it stood, little changed, at 137%.

Age of the crocodiles: Did age play a role in the gradual movement of the crocodiles out of the creek? Kar and Bustard (1990) noted that crocodiles moved down the creeks as they grew older and that by their third year they were in the lower portion of the creeks and in the main Bhitarkanika river. Since released crocodiles were all of the same age and since the movement out of the various sectors were spread over more than a full year, it cannot be held to be age specific.

The main question is, where do the crocodiles go? Messel *et al.* (1979) have stated that they move out from areas inhabited by adult crocodiles. We feel that the movement is caused by a strong territoriality of immature crocodiles themselves (Kar and Bustard 1980). This would effectively space the number of crocodiles that can settle in a given stretch of the river *Crocodylus*

TABLE 1
NUMBER OF SALTWATER CROCODILES OBSERVED AND ESTIMATED PRESENT IN EACH SECTOR OF SUHAJORA CREEK

Date of monitoring	Upper 1/3 of creek Observed	Upper 1/3 of creek Estimated	Middle 1/3 of creek Observed	Middle 1/3 of creek Estimated	Lower 1/3 of creek Observed	Lower 1/3 of creek Estimated	Total number Observed	Total number Estimated
Release: 26-28 Feb. 1978	30	(100)	26	(100)	24	(100)	80	(100)
30 Mar.1978	9 (30)	15 (50)	20 (77)	33 (131)	22 (92)	36 (150)	51 (64)	85 (105)
29 Apr. 1978	5 (17)	8 (27)	12 (46)	20 (80)	26 (108)	43 (169)	43 (54)	70 (84)
30 May 1978	1 (3)	2 (7)	11 (42)	18 (69)	22 (91)	36 (150)	34 (42)	57 (70)
28 Aug. 1978	0	0	7 (27)	11 (42)	21 (87)	35 (140)	28 (35)	46 (57)
29 Sep. 1978	0	0	9 (35)	15 (57)	20 (83)	33 (137)	29 (36)	48 (60)
29 Oct. 1978	0	0	8 (31)	13 (50)	16 (67)	26 (108)	24 (30)	40 (50)
27 Dec. 1978	0	0	4 (15)	6 (23)	22 (92)	36 (150)	26 (32)	45 (56)
29 Dec. 1978	0	0	3 (12)	5 (19)	20 (83)	33 (137)	23 (29)	38 (47)
30 Jan. 1978	0	0	1 (4)	2 (8)	17 (71)	28 (116)	18 (22)	30 (37)
26 Feb. 1979	0	0	1 (4)	1 (4)	14 (58)	23 (95)	15 (18)	25 (31)
30 Mar. 1979	0	0	1 (4)	2 (8)	13 (54)	18 (22)	14 (17)	23 (29)
28 Apr. 1979	0	0	1 (4)	2 (8)	10 (41)	17 (71)	11 (13)	18 (22)
25 May 1979	0	0	1 (4)	2 (8)	7 (29)	12 (50)	8 (10)	13 (16)
29 Aug. 1979	0	0	2 (8)	3 (11)	4 (16)	7 (29)	6 (7)	10 (12)
26 Aug. 1979	0	0	2 (8)	3 (11)	3 (12)	75 (21)	5 (6)	8 (10)
30 Sep.1979	0	0	2 (8)	3 (11)	3 (12)	5 (21)	5 (6)	8 (10)
28 Oct. 1979	0	0	1 (4)	3 (11)	3 (8)	3 (12)	3 (3)	5 (6)
27 Feb. 1980	0	0	1 (3)	2 (8)	2 (12)	5 (21)	4 (5)	7 (9)
29 Mar.1980	0	0	1 (3)	2 (8)	3 (8)	3 (12)	3 (3)	5 (6)
28 May1980	0	0	1 (3)	2 (8)	2 (8)	3 (12)	3 (3)	5 (6)
30 July 1980	0	0	1 (3)	2 (8)	2 (8)	3 (12)	3 (3)	5 (6)
29 Sep. 1980	0	0	1 (3)	2 (8)	2 (8)	3 (12)	Rest left	5 (6)
28 Nov. 1980	0	0	1 (3)	2 (8)	2 (8)	3 (12)	into the	5 (6)
30 Dec. 1980	0	0	1 (3)	2 (8)	2 (8)	3 (12)	main river	5 (6)

Estimates are based on assumed sightings of 60% of crocodiles under survey conditions.
Percentages are shown in parentheses. All monitoring results are for crocodiles released in 1978.

porosus is a solitary animal (Kar 1981) and strongly territorial from its third year (Kar and Bustard 1980).

The problem which we are unable to resolve at present is that given a creek with no disturbance factors and possessing ideal crocodile habitat such as Suhajora, why is the number of crocodiles in the creek very low? Good survival rates of released crocodiles have been demonstrated over a period of two years (Kar and Bustard 1990). Suhajora creek is approximately 6 km long and 4 km of this is good habitat with a resident population of five juveniles, one sub-adult and one pair of adults.

It is estimated that five of the released crocodiles remained in Suhajora creek. Along with the existing population the total of 13 individuals gives a density of only three crocodiles per kilometre.

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References

Bustard, H.R. (1974): A preliminary survey of the prospects for crocodile farming (India). FO: IND/71/-033 October 1974. FAO, Rome.

Bustard, H.R. (1975): Gharial and crocodile conservation management in Orissa (India). *ibid*. December 1975. FAO, Rome.

Kar, S.K. (1981): Studies on the salt water crocodile (*Crocodylus porosus* Schneider). Ph.D. Thesis submitted to Utkal University, Orissa, India.

Kar, S.K. & Bustard, H.R. (1980): Territoriality in immature captive salt water crocodiles (*Crocodylus porosus* Schneider). *J. Bombay nat. Hist. Soc. 77 (1):* 148-149.

Kar, S.K. & Bustard, H.R. (1989): Status of the salt watercrocodiles (*Crocodylus porosus* Schneider) in the Bhitarkanika Wildlife Sanctuary, Orissa, India. *J. Bombay nat. Hist. Soc. 86 (2):* 141-150.

Kar, S.K. & Bustard, H.R. (1990): Pilot re-stocking of salt water crocodiles (*Crocodylus porosus* Schneider) in Bhitarkanika Wildlife Sanctuary. *J. Bombay nat. Hist. Soc. 87(2):* 195-200.

Messel, H., Gans, C., Wells, A.G., Green, W.J., Vorlicek, G.C. & Brennan, K.G. (1979): Survey of tidal river systems in the Northern Territory of Australia and their crocodile populations. Monograph No. 2. The Victoria and Fitzmaurice river systems. Pergamon Press (Australia).

HABITAT ECOLOGY OF ZYGOPTERAN (ODONATA) NYMPHS IN CERTAIN WATER BODIES OF MADHYA PRADESH [1]

S. Kaushik, S. Sharma, M.N. Saxena and D.N. Saksena[2]

The distribution of zygopteran (Odonata) nymphs and their association with macrophytes in certain clean and polluted water bodies of Madhya Pradesh have been described. 16 species of zygopteran insects were identified on the basis of last instar nymphal stages. *Neurobasis chinensis chinensis* and *Pseudagrion spencei* were found at higher altitude (1067 m above msl) and *Copera marginipes*, *Ischnura delicata*, *I. rufostigma*, *Pseudagrion laidlawi* and *Rhodischnura nursei* were observed at lower altitudes (205 to 318 m above msl). *Copera marginipes*, *Ischnura rufostigma*, *Lestes praemorsa*, *Neurobasis chinensis chinensis*, *Pseudagrion laidlawi*, *P. spencei*, *Rhinocypha unimaculata* and *Rhodischnura nursei* preferred lotic waters. *Neurobasis chinensis chinensis* and *Pseudagrion spencei* inhabited acidic waters. *Copera marginipes* and *Rhinocypha unimaculata* were found in association with *Vallisneria spiralis* and *Eichhornia crassipes* respectively and *Ischnura rufostigma* along with decaying vegetation. Other species had no specific preference for the macrophytes. The zygopteran nymphs thus were found from clear to polluted waters at various altitudes in association with a variety of habitats.

Introduction

Most of the lakes in the world and many other aquatic systems are shallow and thus likely to offer sites for submerged macrophytic communities (Wetzel 1975). Such aquatic macrophytes may contribute considerably to the productivity of the water body and provide suitable places for hiding, breeding, egg laying, anchorage, rich oxygen supply and also the food supply for all groups of aquatic insects (Krecker 1939, Andrews and Hasler 1943, Cover and Harrel 1978, Das and Bisht 1979 and Pandit *et al.* 1985).

The insect and macrophyte communities in an aquatic ecosystem remain interdependent ecologically (Pandit *et al.* 1985) and therefore, a great interest in aquatic insects with regard to their habit and habitat in relation to the environment has been shown during recent years (McGaha 1952, Krull 1970, Soszka 1975a, Rosenberg 1986 and Kaushik *et al.* 1990). Observations on the distribution, habit and habitat of zygopteran (Odonata) nymphs from various water bodies of Madhya Pradesh in relation to their physico-chemical characteristics are presented here.

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Material and Methods

Various lentic and lotic water bodies at Pachmarhi, Reewa, Morena and Gwalior, situated at altitudes of 1067, 318, 300 and 205 m above msl respectively in Madhya Pradesh, were selected for the study.

Zygopteran nymphs were collected with the help of 'D' frame net made of nylon cloth (mesh size 80/sq. cm). The nymphs after segregation were preserved in 90% alcohol with a few drops of glycerin. Identification of these nymphs was based on the characteristics of last instar nymphal stages as suggested by Fraser (1957). Water temperature, dissolved oxygen, pH and chloride were also recorded immediately after collection of water samples at the sites as per the standard methods of APHA (1975). Macrophytes were also collected along the sampling station and preserved in 5% formalin.

The range of physico-chemical characteristics, distribution of zygopteran nymphs and their association with macrophytes have been given in Tables 1, 2 and 3 respectively.

Results and Discussion

The physico-chemical characteristics and abundance of macrophytes influence the distribution of aquatic communities including insects (Pandit *et al.* 1985, Kaushik *et al.* 1990). Out of

TABLE 1
RANGE OF TOLERANCE OF PHYSICO-CHEMICAL CHARACTERISTICS IN VARIOUS ZYGOPTERAN NYMPHS

Name of the species	Altitude (m) above mean sea level	Water colour	Water temperature (°C)	Dissolved oxygen (mg/l)	pH (mg/l)	Chloride
Neurobasis chinensis	1067	Clear	16-24	8.1-11.9	6.0-6.7	19-23
Rhinocypha unimaculata	318-1067	Clear-greenish	24-29	9.5-11.2	6.7-8.0	20-75
Agriocnemis pygmaea	205-1067	Clear-blackish	16-24	5.7-11.9	6.0-8.3	23-120
Ceriagrion coromandelianum	205-1067	Clear-greenish	16-29	8.1-11.9	6.0-8.3	23-114
Enallagma parvum	205-1067	Greenish-blackish	22-26	5.7-10.1	6.0-8.1	69-120
Ischnura delicata	205-318	Greenish	21-29	7.4-10.1	7.2-8.2	30-114
I. senegalensis	205-1067	Greenish-blackish	24-30	5.1-10.0	6.0-8.2	74-597
I. rufostigma	300	Greenish	22-24	7.4-10.1	7.2-7.5	69-74
Pseudagrion rubriceps	205-1067	Clear-blackish	16-30	5.1-11.9	6.0-8.3	23-597
P. laidlawi	300-318	Greenish	22-29	8.4-11.2	7.2-8.0	69-88
P. spencei	1067	Clear	24	8.1-9.5	6.5-6.7	19-20
Rhodischnura nursei	300	Greenish	22-24	7.4-10.1	7.2-7.5	69-74
Lestes praemorsa praemorsa	300-1067	Clear-greenish	16-24	8.4-11.9	6.0-7.8	23-74
Copera marginipes	300-318	Greenish	23-29	9.5-11.2	7.9-8.0	75-88

the water bodies selected — Big fall, Apsara vihar, Patthar chata and Matsya sarovar — the water was comparatively clean and clear while the water in Beehar, Bichhiya, Saank, Asaun, Kuari rivers and Ganga sagar tank was turbid and light green in colour due to the growth of phytoplankton. Lotus pool, Vivek nagar pond, Chandanpura pond and Moti mahal tank were polluted by domestic and municipal wastes, while J.C. Mill pond received cotton mill effluents.

Temperature and dissolved oxygen in environments have great bearing on both terrestrial and aquatic communities. Water temperature and dissolved oxygen were found to show a wide range of variation in the water bodies selected for the study. Highest water temperature and lowest dissolved oxygen was measured in J.C. Mill pond while lowest temperature and highest dissolved oxygen was observed in Big fall waters.

Hydrogen ion concentration of natural waters is another important environmental factor. Its variations are linked, among other causes, with the species composition and life processes of constituent biological communities (Jhingran 1982). The nature of all water bodies at Pachmarhi was found to be slightly acidic. It may be due to the presence of decaying vegetation. This decaying vegetation increased the concentration of CO_2 and thus decreased pH. These findings are in agreement with Irwin and Stevenson (1951). The alkaline nature (pH 7.2 to 8.3) of water bodies at Rewa, Morena, and Gwalior may be due to ionic composition and greater photosynthetic activity of algae (Goel *et al.* 1986).

Chlorides occur naturally in all types of waters. The most important sources of chloride in natural waters are from sewage discharge and industrial waste and the salts of sodium, potassium and calcium. The lowest chloride value (19 mg/l) was recorded in Patthar chata while the highest (597 mg/l) was found in J.C. Mill pond, indicating organic pollution (Table 1). Sharma *et al.* (1978) have also reported that increased chloride concentration of water is indicative of pollution.

16 species of zygoptera were identified, out of which 12 species belonging to Coenagriidae and 1 species each to Lestidae, Agriidae, Platycnemididae and Chlorocyphidae were recorded from various water bodies in Madhya Pradesh (Table 2). The distribution of zygopteran insects with regard to altitude indicates that *Neurobasis chinensis chinensis* and *Pseudagrion spencei* were recorded in hilly areas of Pachmarhi located at an altitude of 1067 m, while *Copera marginipes, Ischnura delicata, I. rufostigma,*

TABLE 2
HABITAT DISTRIBUTION OF ZYGOPTERAN NYMPHS IN CERTAIN WATER BODIES OF MADHYA PRADESH

Species	Pachmarhi				Rewa		Morena			Gwalior					
	1*	2*	3*	4**	5*	6*	7*	8*	9*	10**	11**	12**	13**	14**	15**
Family -AGRIIDAE															
Neurobasis chinensis chinensis	+	+	+	–	–	–	–	–	–	–	–	–	–	–	–
Family -CHLOROCYPHIDAE															
Rhinocypha unimaculata	–	+	–	–	–	+	–	–	–	–	–	–	–	–	–
Family -COENAGRIIDAE															
Agriocnemis pygmaea	+	–	–	+	–	–	+	+	–	–	–	+	–	–	–
Ceriagrion coromandelianum	+	–	–	–	–	+	+	+	+	–	–	+	+	–	–
Ceriagrion sp.	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Enallagma parvum	–	–	–	+	–	–	–	+	–	–	–	–	–	+	–
Ischnura delicata	–	–	–	–	+	–	+	+	+	+	+	–	+	–	–
I. senegalensis	–	–	–	+	+	–	+	–	–	–	–	–	–	+	+
I. rufostigma	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Ischnura sp.	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–
Pseudagrion rubriceps	+	–	–	+	–	+	+	–	–	+	–	+	+	+	+
P. laidlawi	–	–	–	–	–	+	+	+	+	–	–	–	–	–	–
P. spencei	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–
Rhodischnura nursei	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
Family-LESTIDAE															
Lestes praemorsa praemorsa	+	–	–	–	–	–	+	–	–	–	–	–	–	–	–
Family-PLATYCNEMIDIDAE															
Copera marginipes	–	–	–	–	–	+	–	–	–	+	–	–	–	–	–

1. Big fall, 2. Apsara Vihar, 3. Patthar chata, 4. Lotus pool, 5 Beehar river, 6. Bichhiya river, 7. Saank river, 8. Asaun river, 9. = Kuari river, 10. Matsya sarovar, 11 = Ganga sagar tank, 12. Vivek nagar pond, 13. Chandanpura pond, 14. Moti mahal tank, 15. J.C. Mill pond.
* = Lotic; ** = Lentic; + = Present; — = Absent.

TABLE 3
SHOWING ASSOCIATION OF MACROPHYTES AND ZYGOPTERAN NYMPHS

	Zygopteran species															
Macrophytic species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Potamogeton crispus	–	–	+	+	–	–	+	+	–	–	–	+	–	+	+	–
P. demersum	–	–	+	+	–	+	+	–	–	+	+	–	–	–	–	–
P.pectinatus	–	–	–	+	+	–	+	+	–	–	–	+	–	+	+	–
Vallisneria spiralis	–	–	+	+	–	+	–	+	–	+	+	+	–	+	+	+
Hydrilla verticillata	+	–	–	+	–	+	–	+	–	–	–	+	–	–	–	–
Cynodon dactylon	–	–	+	+	–	–	–	+	–	–	–	–	–	–	–	–
Lemna pancicostata	–	–	–	–	–	+	–	–	+	+	–	–	–	–	–	–
Ipomoea festulosa	–	–	–	+	–	–	–	+	–	–	+	+	–	–	–	–
Eichhornia crassipes	–	+	+	+	+	–	–	+	–	–	+	–	+	–	+	–
Ceratophyllum demersus	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–
Utricularia stellaris	+	–	–	–	–	+	–	+	–	–	+	–	–	–	–	–
Jussiaea repens	–	–	+	–	–	–	–	+	–	–	+	–	–	–	–	–
Azolla sp.	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–
Zennichellia sp.	–	–	–	+	–	+	–	–	–	+	+	–	–	–	–	–
Decaying vegetation	+	–	–	–	–	–	+	–	+	–	–	+	+	–	+	–

1. *Neurobasis chinensis chinensis*, 2. *Rhinocypha unimaculata*, 3. *Agriocnemis pygmaea*, 4. *Ceriagrion coromandelianum*, 5. *Ceriagrion* sp., 6. *Enallagma parvum*, 7. *Ischnura delicata*, 8 *I . senegalensis*, 9. *I. rufostigma*, 10. *Ischnura* sp., 11 *Pseudagrion rubriceps*, 12 . *P. laidlawi*, 13. *P. spencei*, 14. *Rhodischnura nursei*, 15. *Lestes praemorsa praemorsa*, 16. *Copera marginipes*. + Present; — Absent.

Pseudagiron laidlawi and *Rhodischnura nursei* were observed at an altitude of 205 m to 318 m only.

Agriocnemis pygmaea, Ceriagrion coromandelianum, Enallagma parvum, Ischnura senegalensis, Lestes praemorsa praemorsa, Pseudagrion rubriceps and *Rhinocypha unimaculata* were widely distributed from higher to lower altitudes.

Copera marginipes, Ischnura rufostigma, Lestes praemorsa praemorsa, Neurobasis chinensis chinensis, Pseudagrion laidlawi, P. spencei, Rhinocypha unimaculata and *Rhodischnura nursei* indicated their preference for lotic water, while other species were present in both lotic as well as lentic waters.

Pseudagrion rubriceps was observed in both clean and polluted waters and thus accepted a wide range of water temperature and chloride concentration (Table 1). *Ischnura senegalensis* was found in waters with high concentration of chloride. Hynes (1974), Roback (1974) and Perry (1981) have also reported similar observations regarding the tolerance for a wide range of physico-chemical characteristics of water by species of *Ischnura*. *Neurobasis chinensis chinensis* and *Pseudagrion spencei* were collected from hilly lotic waters with slightly acidic pH and low concentration of chlorides (Table 1).

Since macrophytes provide food and shelter to many macroinvertebrate communities in water, the former have been found to harbour zygopteran nymphs also. The association of various zygopteran nymphs with different species of macrophytes has been shown in Table 3. *Ceriagrion coromandelianum, Ischnura senegalensis* and *Pseudagrion rubriceps* have been found in association with at least 10 species of macrophytes without any specific preference. *Copera marginipes* and *Rhinocypha unimaculata* have strong affinity for *Vallisneria spiralis* and *Eichhornia crassipes* respectively, while *Ischnura rufostigma* was always found along with decaying vegetation. However, *Rhinocypha unimaculata* and *Ceriagrion coromandelianum* were also observed clinging to rocks and algal growth in water respectively.

Odonatan nymphs are believed to inhabit clean waters with sufficient oxygen (Tonapi 1980). This is, however, not true in the present study. The zygopteran nymphs have been observed from clean to polluted waters and were found to prefer a variety of macrophytic habitat as has been suggested by Roback (1974), Hynes (1974) and Perry (1981).

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REFERENCES

ANDREWS, J.D. & HASLER, A.D. (1943): Fluctuations in the animal populations of the littoral zone in lake Nendota. *Trans. Wis. Acad. Sci. Arts Let. 35:* 175-185.

APHA (1975): Standard methods for the examination of water, sewage and industrial waste. (14th ed.). American Public Health Association, New York.

COVER, E.C. & HARREL, R.C. (1978): Sequence of colonization, diversity, biomass and productivity of macro-invertebrates on artificial substrates in a freshwater canal. *Hydrobiologia 59:* 81-95.

DAS, S.M. & BISHT, R.S. (1979): Ecology of some hemiptera and Coleoptera of Kumaun lakes. *Ind. J. Ecol. 6(1):* 35-40.

FRASER, F.C. (1957): A reclassification of the order Odonata. *R. Zool. Soc. N.S.W. Handbook* No. 12.

GOEL, A.K., KHATARKAR, S.D., KULKARNI, A.Y. & TRIVEDI, R.K. (1986): Limnological studies of a few fresh water bodies in South Western Maharashtra with special reference to their chemistry and phytoplankton. *Indian Poll. Res. 5(2):* 79-84.

HYNES, H.B.N. (1974): The biology of polluted waters. Univ. Toronto Press, Toronto.

IRWIN, W.H. & STEVENSON, J.H. (1951): Physicochemical nature of clay turbidity with special reference to clarification and productivity of impoundment waters. *Okla Agr. Mech. Coll. Bull. 48:* 1-54.

JHINGRAN, V.G. (1982): Fish and Fisheries of India. Hindustan Publishing Corporation (India), Delhi.

KAUSHIK, S., SHARMA, S., SAXENA, M.N. & SAKSENA, D.N. (1990): Habitat ecology of Anisopteran nymphs in certain water bodies of Madhya Pradesh. *Acta Hydrochim. hydrobiol. 18(4):* 443-447.

KRECKER, F.H. (1939): A comparative study of the animal population of certain submerged aquatic plants. *Ecology 20:* 553-562.

KRULL, J.N. (1970): Aquatic plant microinvertebrate associations and water fowl. *J. Wildlife Manage. 34(4):* 707-718.

McGAHA, Y.J. (1952): The limnological relations of insects of certain aquatic flowering plants. *Trans. Am. Microscop. Soc. 71(4):* 355-381.

PANDIT, A.K., PANDIT, S.N. & KAUL, V. (1985): Ecological relations between invertebrates and submerged macrophytes in two Himalayan lakes. *Poll. Res. 4(2):* 53-58.

PERRY, T.E. (1981): Dragonflies and damselflies (Odonata) of the Grand river system, Northeastern Ohio, 1974-1978. *Ohio J. Sci. 81(3):* 125-131.

ROBACK, S. (1974): Insects. *In:* Pollutional Eology of fresh water invertebrates (Eds.) C.W. Hart and S.L.H. Fuller. Academic Press, New York.

ROSENBERG, M. D. (1986): Importance of insects in environmental impact assessment. *Environmental Management 10(6):* 773-783.

SHARMA, K.P., GOEL, P.K. & GOPAL, B. (1978): Limnological studies of polluted fresh water I. Physico-chemical characteristics. *Int. J. Ecol. Environ. Sci. 4:* 89-105.

SOSZKA, G.J. (1975a): The invertebrates on submerged macrophytes in three Masurian lakes. *Ekol. Poll. 23 (3):* 371-391.

SOSZKA, G.J. (1975b): Ecological relations between invertebrates and submerged macrophytes in the lake littoral. *Ekol. Poll. 23(3):* 393-415.

TONAPI, G.T. (1980): Fresh water animals of India. Oxford and IBH Publishing Co., New Delhi.

WETZEL, R.G. (1975): Limnology. W.B. Saunders, Philadelphia.

NEW DESCRIPTIONS

A NEW SPECIES OF *COPIDOGNATHUS* (HALACARIDAE : ACARI) FROM CHILKA LAGOON (BAY OF BENGAL)[1]

TAPAS CHATTERJEE[2]

(With eleven text-figures)

A new species of halacarid (Acari), *Copidognathus sambhui*, is described from Chilka lagoon. Its similarity and dissimilarity with related species is discussed.

INTRODUCTION

Although there exists considerable information on the biosystematics of the estuarine and brackish halacarids outside the subcontinent (Bartsch 1972, 1975, 1979, 1982; Green,1968, Green and Macquitty 1987, Morselli and Mari, 1978, 1981; Newell 1947), virtually no published information on the systematics of these meiobenthic organisms is available from similar environs of the country except for group level density and biomass recordings in meiobenthos publications. The biomass and numerical density distribution patterns of halacarids of Chilka lagoon (19°28′ to 19°54′ N, 85°6′ to 85°35′ are known through the works of Sarma and Rao 1980, Sarma and Satapathy 1980, Sarma *et al.* 1981. Since the halacarid fauna of this largest brackish-water body of the country has remained undocumented so far, an attempt was made to make a comprehensive probe into the lagoon for these organisms. While engaged in this research, an undetermined species of the genus *Copidognathus*, encountered among the weed washing of *Potamogaton pectinatus* was found to be new to science and is described here.

Copidognathus sambhui [3] sp. nov.

Classification: Classification adopted here is that of Krantz (1978) and Bartsch (1983).

Type: Holotype (Male) is in the author's collection in the Department of Life Science, Regional College of Education, Bhubaneswar.

Description: Male-the idiosomal length of holotype is 337 µ.

All dorsal plates are separate (Fig. 1) Anterodorsal plate (AD) with a gable-like area frontally. AD with three areolae; anterior areola is small and rounded, comprising 7-8 rosette pores. The posterior two areolae are long and divergent both anteriorly and posteriorly, with their convex inner margins closely juxtaposed against each other (Fig. 3). Dorsal setae I (DS_1) are located anteriorly on AD and are not immediately discernible. Ocular plate (OC) bears two corneae and rosette pores in corneal zone. The OC tapers posteriorly, extending a little beyond the insertion of leg III. Dorsal setae II (DS_2) present in the middle of anterior margin of OC. There are 4 costae embedded in Postero-dorsal plate (PD). The middle two costae are two rosette pores wide. The paracostae are present close to the lateral margin of PD. Anterior margin of PD is straight. The dorsal seta III, IV and V (DS_3, DS_4, DS_5) are located in the anterior, middle and posterior reaches of PD respectively between the middle costae and paracostae.

All ventral plates are separated by narrow membranous areas (Fig. 2). Areolae made up of rosette pores are present on first and second coxal prominences of Anterior Epimeral plate (AE). AE with 3 pairs of setae. Epimeral process I (EP_1) conspicuous and is coxal in origin (Fig. 4). Posterior epimeral plate (PE) with 3 ventral and 1 dorsal setae. Genitoanal plate (GA) bears

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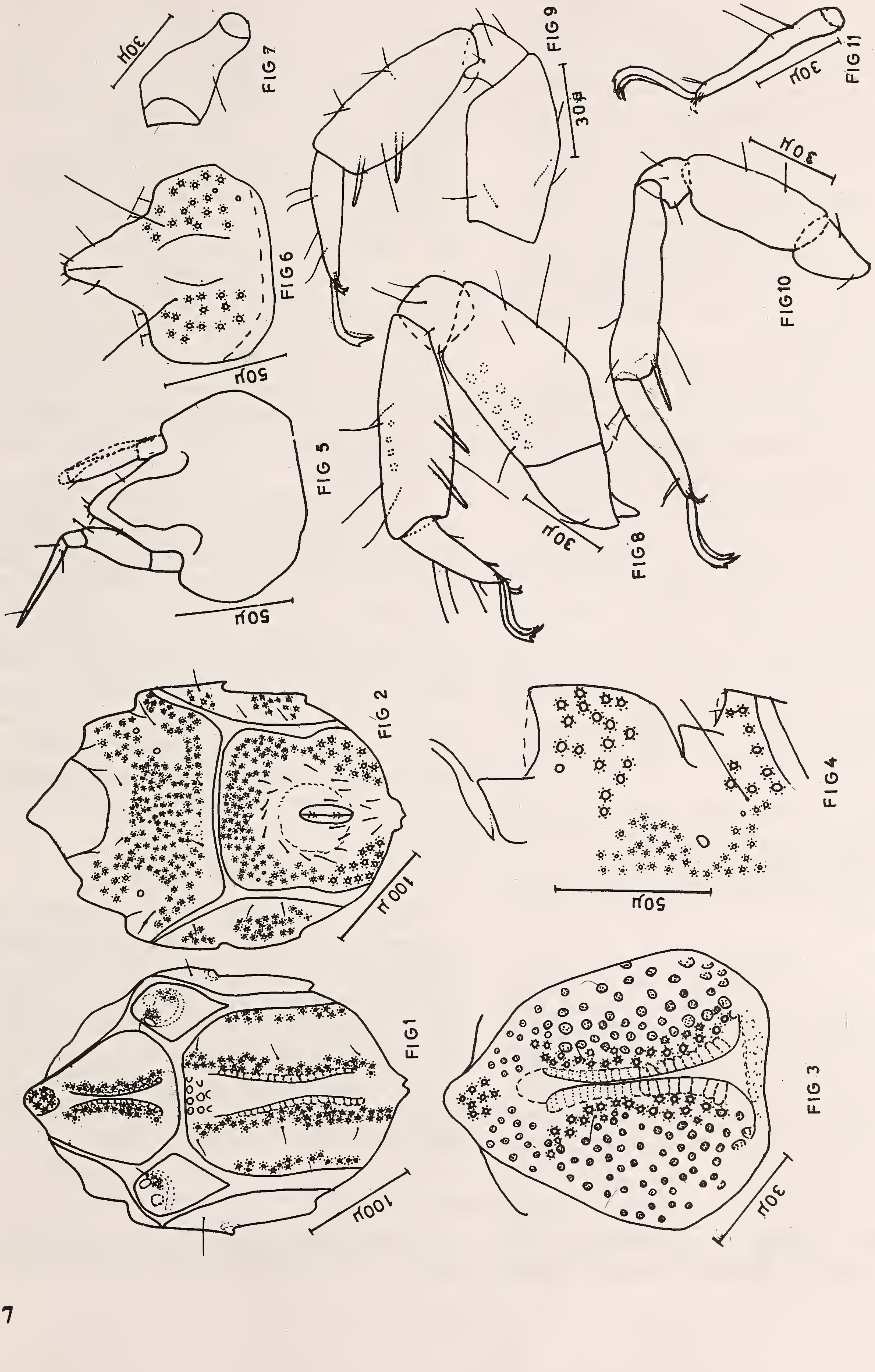

Figs 1 - 11. *Copidognathus sambhui* sp. nov. 1. Idiosoma dorsal, male, 2. Idiosoma ventral, male, 3. Anterodorsal plate, 4. Epimeral area I and II, 5. Gnathosoma dorsal, 6. Gnathosoma ventral, 7. Trochanter III, 8. Basifemur – tarsus of leg I, 9. Telofemur – tarsus of leg II, 10. Basifemur – tarsus of leg III, 11. Tarsus of leg IV.

paragenital areolae. There are 19 perigenital setae (PGS) around the Genital Opening (GO) and four pairs of Subgenital setae (SGS) in the GO.

Rostrum stout and short, extending up to two thirds the length of the palpal femur. Ventral side of the gnathosoma bears rosette pores laterally (Fig. 6). Tectum long and stout (Fig. 5). Gnathosoma with a pair of basirostral setae and a pair of proto-, deuto-and trito-rostral setae. Palp is 4-segmented. Palpal trochanter and patella without any setae. Palpal femur with single dorsal seta; palpal tibiotarsus with 3 basal setae and singlet eupathidia distally.

Trochanter III is clavate (Fig. 7).

Tibiae I and II with three ventral (two pectinate and one smooth slender) and four dorsal setae (Figs. 8, 9). Porose panels present dorsolaterally on telofemur I, ventrolaterally on tibia I. Telofemorae III and IV devoid of any ventral setae. Tarsus I bears 3 dorsal fossary setae, 1 solenidion, 1 profamulus besides 3 ventral setae (one filiform seta basally, two eupathidia distally) and 4 Parambulacral setae (PAS) (2 doublets eupathidia, Fig. 8). Tarsi II-IV without any ventral setae. Tarsus II with 3 fossary setae, one solenidion, and 2 PAS (singlet eupathidia) (Fig. 9). Tarsi III and IV with 3 dorsal fossary setae and one proximodorsal seta besides two PAS (Figs. 10, 11).

All legs with two lateral claws and one bidentate median claw. Lateral claws ventrally smooth and bear a minute dorsal tooth.

Females and nymph: not encountered in the sample collected.

Discussion

The present species can be aligned with Newell's key group 5200 (Newell 1984) due to the presence of EP_1 coxal in origin, DS_2 and DS_3 on OC and PD respectively. Single pair basirostral seta, telofemorae III–IV devoid of ventral setae and Membranous cuticle (MC) with parallel striae.

C. sambhui sp. nov. is distinct from all the species of the key group 5200 (Newell 1984) in that the posterior two areolae on AD are long and divergent both anteriorly and posteriorly with their convex inner margins juxtaposed against each other. In addition, PD is quadrate.

However, the present species resembles *C. acnemus* Bartsch 1986, *C. brachyrhynchus* Andre 1959, *C. tectirostris* Bartsch 1978, *C. perforatus* Viets 1940 and *C. sculptus* (Police 1909) due to presence of a stout and long projection on tectum. However, the latter two species have round or pear-shaped posterior areolae strikingly different from the species under discussion. *C. acnemus* is distinct due to dumbell-shaped posterior areolae. The posterior areolae in *C. brachyrhynchus* are bean-shaped while in *C. tectirostris* they are inverted Y-shaped.

Thus an anterior gable-like area; AD with two long divergent posterior areolae, quadrate PD; well developed costae and paracostae and small EP_1 coxal in origin readily differentiate and characterise the present species. *C. sambhui* sp. nov. has also similarities with *C. faubeli* Bartsch 1986. Both the species have 'gable-like' frontal area on AD; OC of similar shape; PD with 4 costae and EP_1 coxal in origin. But in *C. faubeli* the two posterior areolae on AD are united together, unlike *C. sambhui* sp. nov. in which the two posterior areolae are divergent both anteriorly and posteriorly.

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Thanks are due to Dr A.L.N. Sarma, I/C Zoology Div., Regional College of Education, Bhubaneswar for critically going through the manuscript and constant guidance; to Dr Ilse Bartsch, Biologische Anstalt Helgoland, Hamburg (FRG) for readily providing the necessary literature and helpful suggestions and to the authorities of Regional College of Education, Bhubaneswar for laboratory facilities.

References

Andre, M. (1959): Contribution a l'atude des Halacariens de la Mer Rouge - *Mission Robert, Ph. Dollfus en Egypte* 1927-29, *29:* 93-119.

Bartsch, I. (1972): Ein Beitrag, Biologie und Okologie der

Halacaridae (Acari) aus dem Litoral der Nord und Ostsee. I systematik und Biologie. *Abh. Verh. naturwiss. 16:* 155-230.

Bartsch, I. (1975): Ein Beitrag Zur Rhombognathinen - Fauna (Halacaridae, Acari) der Bretagnekuste. *Acarologia 17:* 53-80.

Bartsch, I. (1978): Eranzungen zur copidognathus - Fauna (Halacaridae: Acari) der Bretagne - kuste. *Acarologia 20:* 217-234 (Published in 1979).

Bartsch, I. (1979): Halacaridae (Acari) von der Atlantikkuste Nordamerika Beschreibung der Arten. *Mikrofauna Meeresboden. 79:* 1-62.

Bartsch, I. (1982): Halacaridae (Acari) von der Atlantikkuste des borealen Nordamerikas. Okologische und tiergeographische Faunenanalyse. *Helgolander Meeresunters 35:* 13-46.

Bartsch, I. (1983): Vorschlag Zur Neugliederung des systems der Halacaridae (Acari). *Zool. Jb. Syst. 110:* 179-200.

Bartsch, I. (1986): Three new species of *Copidognathus* (Acari: Halacaridae) from the Philippines. *Philip. J. Sci. 115:* 43-54.

Green, J. (1968): The biology of estuarine animals. Sidgwick & Jackson, London. pp. 233-235.

Green, J. & Macquitty, M. (1987): Halacarid mites. *Synopses Br. Fauna (NS) 36:* 1-178.

Krantz, G.W. (1978): A manual of acarology, 2nd edn. Oregon State Univ. Book Store:

Morselli, I. & Mari, M. (1978): Alacaridi Di Acque Lagunari E. Costiere Della Toscana Meridionale. *Atti. Soc. Tosc. Sci. Nat. Mem. Serie. B. 85:* 63-86.

Morselli, I. & Mari, M. (1981): *Anomalohalacarus affinis* n. sp. un alacaride. (Halacaridae) Acari delle coste Toscana. ibid. *87:* 275-283.

Newell, I.M. (1947): A systematic and Ecological study of the Halacaridae of Eastern North America. *Bull. Bingham Ocean. Coll. 10:* 1-247.

Newell, I.M. (1984): Antarctic Halacaroidea. *Antarct. Res. Ser. 40:* 1-284.

Police, G. (1909): Alcune nuove specie di Halacridae de Golfo di Napoli. *Arch. Zool. Napoli. 3:* 409-443.

Sarma, A.L.N. & Rao, D.G. (1980): The meiofauna of Chilka lake (Brackish water lagoon). *Curr. Sci. 49:* 870-872.

Sarma, A.L.N. & Satapathy, S. (1980): A note on the phytal fauna in and around Balugaon in Chilka lake. *Curr. Sci. 47:* 242- 245.

Sarma, A.L.N., Satapathy, S. & Rao, D.G. (1981): Phytal macro and meiofauna of Chilka lake. *Ind. J. Mar. Sci. 10:* 61-65.

Viets, K. (1940): Meer esmilben aus der Adria (Halacaridae und Hydrachnellae, Acari). *Arch. Naturgesch. 9:* 1-135.

APHIDIID (HYMENOPTERA: APHIDIIDAE) FAUNA OF GARHWAL, WESTERN HIMALAYA[1]

B.C. Das[2] and S. Chakrabarti[3]

(With nine text-figures)

Fifteen species of aphidiid (Hymenoptera: Aphidiidae) are recorded as parasitoids of aphids (Homoptera: Aphididae) from Garhwal range of western Himalaya. Out of these, 1 species, viz. *Aphidius polycostulari*, is new to science, two species, viz. *Praon orientale* Stary & Schlinger and *Praon pubescens* Stary, are new to Indian subregion and the rest are new to the Garhwal range of western Himalaya.

Garhwal range of western Himalaya comprises 214 aphid species (Saha and Chakrabarti 1987). Das and Chakrabarti (1986, 1988 a, b, c, 1989 a, b, c, 1990) altogether reported 20 aphidiid species under 8 genera attacking only 14% of the total aphid species from the said range of Himalaya. An additional 15 aphidiid species under 8 genera are recorded in this paper, increasing the number of species from the area to 35 under 11 genera, attacking about 20% of the total aphid species. Out of the present 15 aphidiid species, one species, viz. *Aphidius polycostulari*, is new to science and two species, viz. *Praon orientale* Stary, and Schlinger and *Praon pubescens* Stary, are new to the Indian subregion. The rest of the species except *Lysaphidus qadrii* Shuja-Uddin are recorded here for the first time from the state of Uttar Pradesh. All these species are new to Garhwal range of western Himalaya.

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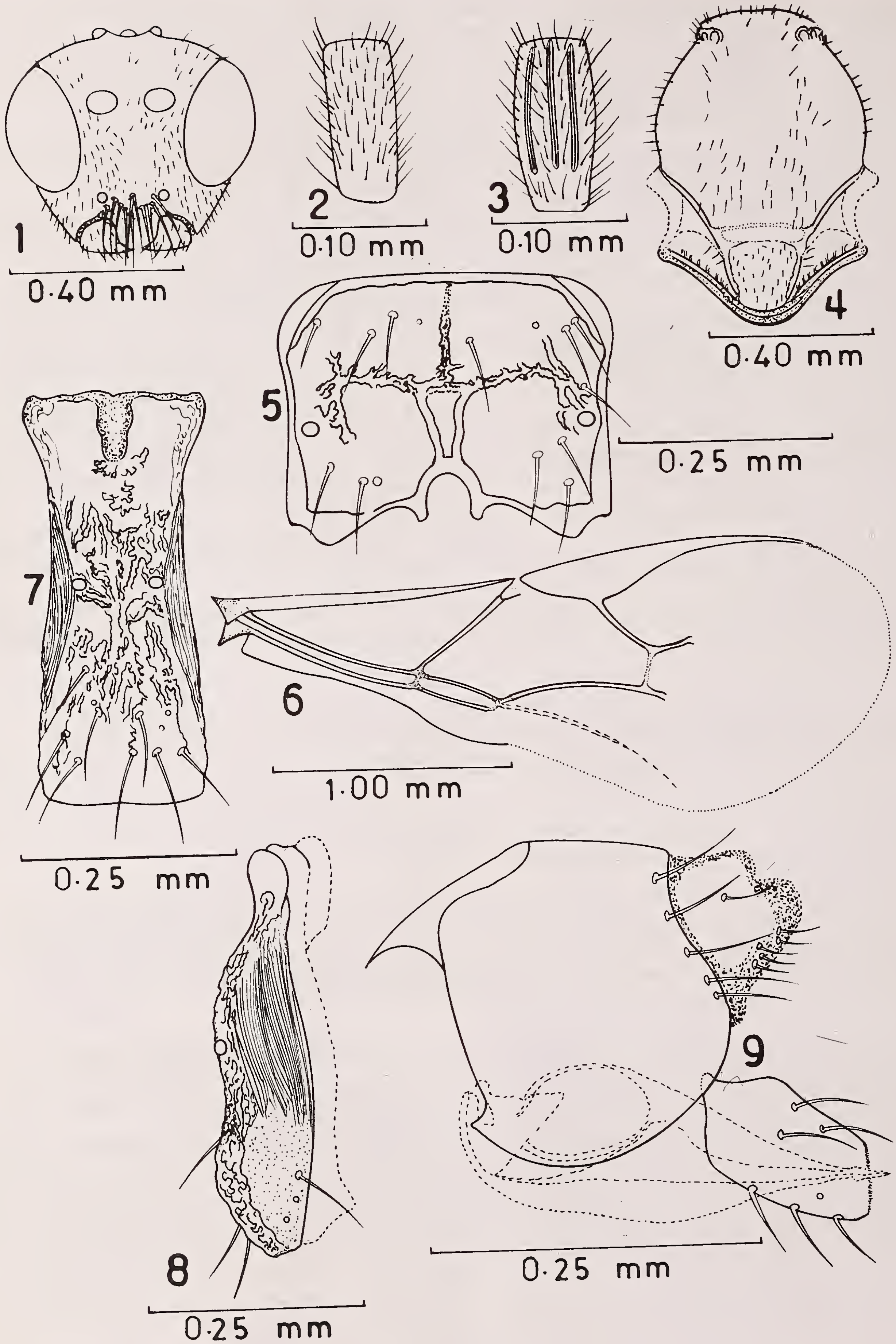

Figs. 1 - 9. *Aphidius polycostulari* sp. nov, female. 1. Head, 2. First flagellar segment, 3. Second flagellar segment, 4. Mesonotum, 5. Propodeum, 6. Forewing, 7. Dorsal aspect of tergite1, 8. Lateral aspect of tergite 1, 9. Genitalia..

Aphidius absinthii Marshall

Specimens studied: 5 females and 2 males, ex. *Macrosiphoniella kikungshana* Takahashi on *Artemisia* sp., *c.* 1875 m, 21 Aug. 1983; 2 females and 1 male, ex. Macrosiphoniella sp. on *Chrysanthemum* sp. Joshimath (*c.* 1875 m), 19 March 1984; 5 females, ex. unknown on *Artemisia* sp., Barkot (*c.* 1450 m), 25 May1984 (coll. B.C. Das).

Aphidius cingulatus Ruthe

Specimens studied: 5 females, ex. *Pterocomma* sp. on *Salix tetrasperma* Roxb., Lambagarh (*c.* 2300 m), 22 July 1983 (coll. B.C. Das); 1 female, ex. *Pterocomma* sp. on *Populus citiata* Wall. Joshimath (*c.* 1875 m), 27 March 1984 (coll. K. Dey).

Aphidius polycostulari sp. nov. (Figs. 1-9)

Morphological characters: Females: Head (Fig. 1) transverse, smooth, shiny, sparsely haired; face with a narrow longitudinal area which is bordered by simple rows of hairs, the area between the rows and orbits with sparse hairs; longitudinal eye diameter 3.50± 0.35 x width of gena; tentorial index 0.55 ± 0.04; interocular line subequal to facial line, 1.67 ± 0.14 x transfacial line; transverse eye diameter 1.20 ± 0.04 x temple; ocellar triangle right; clypeus with 10-12 long hairs. Antennae 18-segmented, reaching to the end of tergite 3; F_1 (Fig. 2) little shorter than length of F_2 (Fig. 3); length of F_1 2.53± 0.49 x width at base; length of F_2 3.38 ± 0.24 x width at base; F_1 with 0 and F_2 with 3 rhinaria.

Mesoscutum of mesonotum (Fig. 4) with short hairs almost in two longitudinal rows on disc except near the prescutellar groove which is comparatively densely haired; notaulices distinct at the ascendent part, deep, crenulated, effaced on disc. Scutellum narrow, rugose, with comparatively dense short hairs on disc. Central areola of propodeum (Fig. 5) comparatively narrow. Upper longitudinal and lateral transverse carinae with many irregular processes; upper longitudinal carinae somewhat effaced before the upper margin of propodeum; upper areola with 4-6 and lower with 3-4 long hairs.

Pterostigma of forewing (Fig. 6) elongatedly triangular, length 3.60 ± 0.25 x width, 1.27± 0.06 x length of metacarp; length of radial abscissa 1 was 1.60 ± 0.09 x length of radial abscissa 2.

Length of tergite 1 (Fig. 7) 3.31 ± 0.36 x width at spiracles; dorsal surface with irregular net-like crenulation; lower portion with 8-14 long hairs; anterolateral area longitudinally costulated, number of costulae 25-30 (Fig. 8). Ovipositor sheaths (Fig. 9) slender, maximum length 1.94 ± 0.06 x maximum width; ovipositor as in figure.
Coloration: Head deep brown; face yellowish orange; mouth parts yellowish except deep brown apices of mandibles; scape yellowish, pedicel yellowish brown, basal ring of F_1 yellowish, rest of antennae brown; thorax blackish brown except yellowish orange pronotum and propleuron; legs yellowish orange except dark brown apices of tarsi; wing veins brown to colourless; tergite 1 dirty brown, ovipositor sheaths blackish brown, rest of abdomen dirty orange brown to yellowish brown.
Body length: 2.85 ± 0.15 mm.
Measurements of one female (in mm): Body length 2.80. Head: Tentorio-ocular line 0.07, intertentorial line 0.12, interocular line 0.37, facial line 0.38, transfacial line 0.23, width of gena 0.07, longitudinal eye diameter 0.27, transverse eye diameter 0.20, temple 0.17, length of antennae 2.16, length of F_1 0.12, width of F_1 at base 0.05, length of F_2 0.13, width of F_2 at base 0.04. *Forewing:* Length of pterostigma 0.61, width of pterostigma 0.17, length of metacarp 0.48, length of radial abscissa 1 0.28, length of radial abscissa 2 0.17. Tergite 1: length 0.47, width at spiracles 0.14. *Ovipositor sheaths:* Maximum length 0.16, maximum width 0.08.
Male: Antennae 20-segmented, body length 2.56, F_1 with 2-4 and F_2 with 3-6 rhinaria; coloration generally darker than the female, otherwise like the female except for sexual differences.
Mummy: Dark brown.
Holotype: Female; INDIA: Uttar Pradesh, Garhwal, Joshimath (*c.* 1875 m), ex. *Macrosiphum* (*Sitobion*) sp. on *Rosa* sp., 27 October 1981 (coll. A.K. Mandal). Paratypes: 1 female and

1 male, collection data as in the holotype.

The present specimens are closely related with *A. rosae* Haliday (1834) in having tentorial index 0.51-0.59, ocellar triangle right and 18 antennal segments besides its host range. But it differs from the latter species by the number of costulae on anterolateral area of tergite 1, almost incomplete upper longitudinal carina and somewhat short pterostigma (in *rosae* number of costulae is10-18, upper longitudinal carina is complete and pterostigma long).

Aphidius rosae Haliday

Specimens studied: 25 females and 4 males, ex. *Macrosiphum rosae* (Linn.) on *Rosa* sp., Osla (*c.* 2559 m), 8 Sept 1984; Joshimath (*c.* 1875 m), 15 September 1984, 21 April 1985. (coll. B.C. Das).

Aphidius urticae Haliday

Specimens studied: 6 females and 3 males, ex. *Acyrthosiphon* sp. on *Euphorbia pilosa* Linn., Bhyundar (*c.* 3000 m), 18 October 1982 (coll. A.K. Mandal).

Betulaxys intermedius Shuja-Uddin

Specimens studied: 5 females and 3 males, ex. *Capitophorus formosartemisiae* (Takahashi) on *Artemisia vulgaris* Linn., Joshimath (*c.* 1875 m), 27 September 1983 (coll. D. Dangwal); 3 females and 2 males, ex. *Capitophorus* sp. on *Artemisia sp., Taluka (c.* 1950 m), 6 September 1984 (coll. S. Saha).

Ephedrus minor Stelfox

Specimens studied: 1 female, ex. *Cavariella aegopodii* (Scopoli) on *Salix hastata* Linn., Joshimath (*c.*1875 m), 28 Oct.1985 (coll. B.C. Das).

Lipolexis scutellaris Mackauer

Specimens studied: 2 females, ex. *Liosomaphis himalayensis* Basu on *Berberis* sp., Hanumanchatti (*c.* 1900 m), 18 October 1981 (coll. S. Saha); 16 females and 24 males, ex. *Aphis gossypii* Glover on *Rumex* sp., Bhyndar (*c.* 3000 m), 8 October 1983 (coll. B.C. Das).

Lysaphidus qudrii Shuja-Uddin

Specimens studied: 5 females and 3 males, ex. *Brachycaudus helichrysi* (Kaltenbach) on *Anaphalis* sp., Joshimath (*c.* 1875 m), 28 Oct. 1981 (coll. S. Raha); 10 females and 4 males, ex. *Brachycaudus* sp. on *Gnaphalium* sp., Chamoli (*c.* 960 m), 28 October 1981 (coll. A.K. Mandal); 20 females and 7 males, ex. *Capitophorus* sp., on *Anaphalis cinnamomea* Clarke, Musoorie (*c.* 2004 m), 21 April 1984 (coll. B.C. Das).

Praon orientale Stary & Schlinger

Specimens studied: 30 females and 21 males, ex. *Uroleucon* sp., on *Sonchus* sp., Barkot (*c.* 1450 m), 27 June 1983; 10 females and 3 males, ex. *Uroleucon* sp., on *Sonchus arvensis* Linn., Joshimath (*c.* 1875 m), 3 Aug.1984 (coll. B.C. Das).

Praon pubescens Stary

Specimens studied: 2 females, ex. *Nasonovia* sp. on *Strobilanthes* sp., Helong (*c.* 1524 m), 26 July 1983 (coll. B.C. Das).

Praon volucre (Haliday)

Specimens studied: 4 females, *Macrosiphum* sp., on *Rosa* sp., Joshimath (*c* 1875 m), 28 September 1984 (coll. B.C. Das).

Toxares sp.

Specimen studied: 1 female, ex. *Shinjia orientalis* (Mordvilko) on fern, Joshimath (*c* 1875 m), 11 October1983 (coll. B.C. Das).

Trioxys (Binodoxys) centaureae (Haliday)

Specimens studied: 12 females and 5 males, ex. *Uroleucon* sp. on *Senecio* sp., Nannugaon (*c.* 3300 m), 23 June1984 (coll. B.C. Das).

Trioxys (Binodoxys) rubicola Shuja-Uddin

Specimens studied: 20 females and 11 males, ex. *Aphis ruborum longisetosus* Basu on *Rubus ellipticus* Smith, Sakri (*c.* 1800 m), 5 September 1984 (coll. B.C. Das).

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REFERENCES

DAS, B.C. & CHAKRABARTI, S. (1986): Mating and oviposition of *Kashmiria aphidis* (Aphidiidae: Hymenoptera). Proc. 2nd Nat. Symp. Recent Trends in Aphidological Studies Modinagar (Editor S.P. Kurl): 103-117.

DAS, B.C. & CHAKRABARTI, S. (1988a): Immature stages of *Kashmiria aphidis* (Hymenoptera, Aphidiidae). *Acta Entomol. Bohemoslov. 85:* 16-20.

DAS, B.C. & CHAKRABARTI, S. (1988b): Sex ratio of *Kashmiria aphidis* Stary and Bhagat (Hymenoptera: Aphidiidae) in the field. *Ann. Entomol. 6:* 63-66.

DAS, B.C. & CHAKRABARTI, S. (1988c): Seasonal occurrence of *Aphidius matricariae* Haliday (Aphidiidae: Hymenoptera) in Garhwal range of north west Himalaya. *Indian J. Ent. 50:* 388-389.

DAS, B.C. & CHAKRABARTI, S. (1989a): Aphidiid parasitoids (Hymenoptera: Aphidiidae) of graminaceous aphids in Garhwal, western Himalaya. *Orient. Insects. 23:* 365-372.

DAS, B.C. & CHAKRABARTI, S. (1989b): Two new aphid parasitoids (Hymenoptera: Aphidiidae) from Garhwal range of western Himalaya, India. *Entomon 14:* 339-343.

DAS, B.C. & CHAKRABARTI, S. (1989c): *Praon himalayensis*, a new walnut aphid parasitoid (Hymenoptera: Aphidiidae) in Garhwal range of western Himalayas. *Entomon 14:* 345-347.

DAS, B.C. & CHAKRABARTI, S. (1990): New and little known aphidiid parasitoids (Hymenoptera : Aphidiidae) of gall forming aphids in western Himalaya, with notes on their seasonal history. *Orient. Insects 24:* 399-414.

HALIDAY, A.D. (1834): Essay on the classification of parasitic hymenoptera of Britain, which correspond with the *Ichneumones minuti* of Linn. *Ent. Mag. 2:* 93-106.

SAHA, S. & CHAKRABARTI, S. (1987): New records of aphids (Homoptera: Aphididae) from Garhwal range of western Himalaya, India. *J. Bombay nat. Hist. Soc. 85:* 633-635.

A NEW SPECIES OF WHITEFLY *DIALEUROPORA HEPTAPORA* SP. NOV. (ALEYRODIDAE : HOMOPTERA) FROM INDIA[1]

K. REGU AND B.V. DAVID[2]

(With a text-figure)

During the course of field collection of whiteflies, a species of *Dialeuropora* collected from *Hiptage* sp. in Ambalamedu, Kerala, on 4 December 1989 was found to be new to science and is described here.

Dialeuropora heptapora sp. nov. (Fig. 1)

Pupal case: White, oval, thin, found on the lower surface of leaves, 1.08-1.13 mm long and 0.80-0.85 mm wide.

Margin: Crenulate, 16-17 crenulations in 0.1 mm; thoracic and caudal tracheal pores present; anterior marginal setae 20μ long and posterior marginal setae 25 μ long.

Dorsal surface: Four pairs of dorsal setae – cephalic setae 5-7.5 μ long, first abdominal setae 5-12.5 μ long, eighth abdominal setae 5-7.5 μ long and submarginal caudal setae 7.5 μ long. A row of seven pairs of large pores and porettes (4 on cephalothorax and 3 on abdomen on submargin near the margin present. A row of five pairs of submarginal setae (4 on cephalothorax and one on abdomen) each 7.5μ long. Longitudinal moulting suture reaches the margin, whereas transverse moulting suture reaches subdorsum. A pair of thick round markings submedially on each segment present. Numerous thin round markings sparsely distributed throughout the dorsum. Submargin and subdorsum covered with numerous microtubercles.

Vasiform orifice subcircular, wider than

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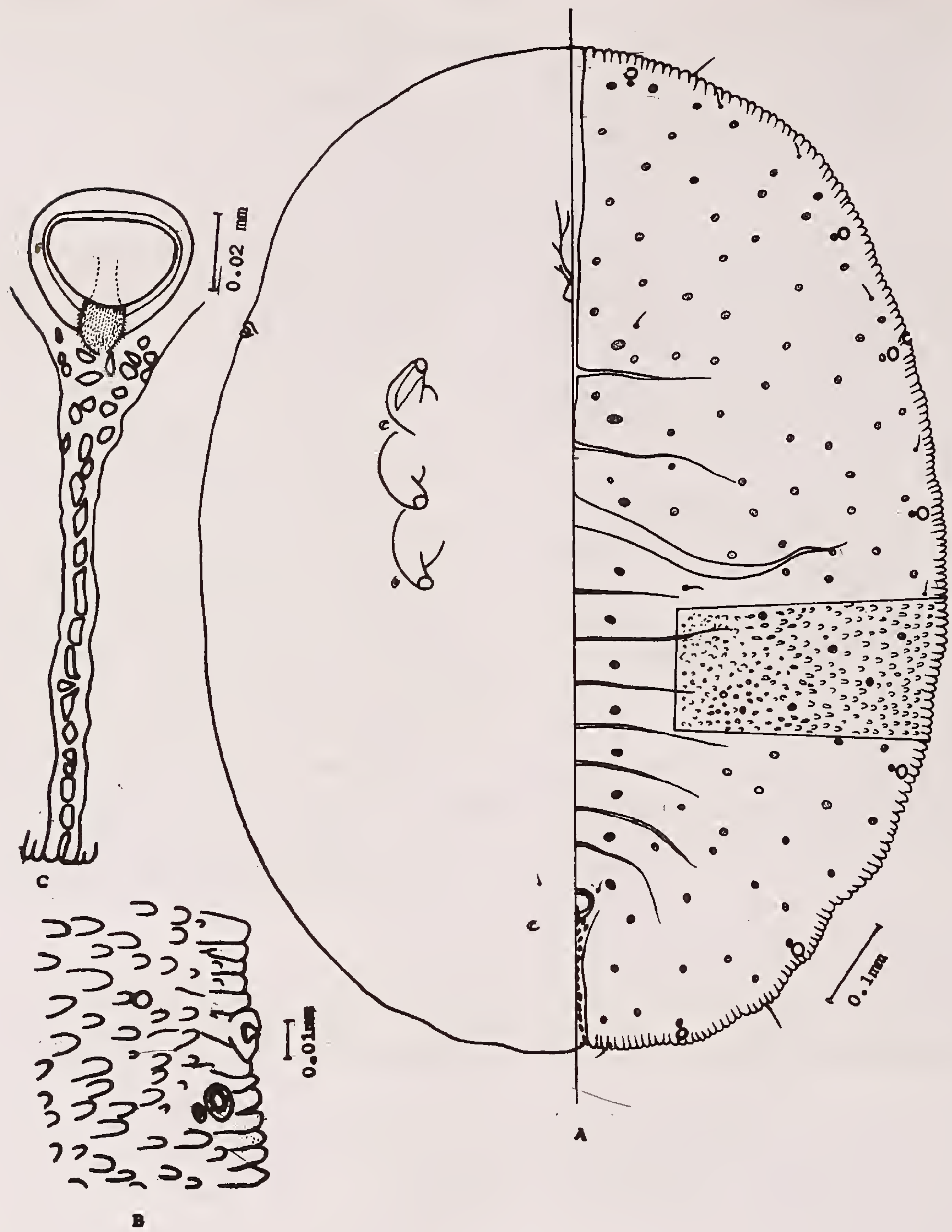

Fig. 1. *Dialeuropora heptapora* sp. nov.

long, 35-42.5 μ wide and 32.5-37.5 μ long; operculum similarly shaped, 27.5-32.5 μ wide and 17.5-22.5 μ long; lingula tip setose and exposed. Caudal furrow very long, 135-150 μ long and 7.5 μ wide. Polygonal markings evident on the caudal furrow and thoracic tracheal furrows indistinct.

Ventral surface: Paired ventral abdominal setae 7.5-17.5 μ long and 40-42.5 μ apart. Antenna reaches near the base of the prothoracic leg.

Host: *Hiptage* sp. (Malpighiaceae).

Material examined: Holotype. *Hiptage* sp., Ambalamedu (Kerala), 14 December1989, Coll. K. Regu.

Paratypes: Six pupal cases on slides bearing the same details as of holotype.

This species resembles *Dialeuropora decempuncta* (Quaintance & Baker) in the shape of vasiform orifice and the exposed lingula tip but it differs from that in the presence of seven pairs of submarginal pores and porettes, five pairs of sub-marginal setae, caudal tracheal furrow with polygonal markings and submargin and subdorsum with numerous microtubercles.

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ON THE GENERA *ASIALEYRODES* CORBETT AND *COCKERELLIELLA* GEN. NOV. FROM INDIA [1]

R. SUNDARARAJ AND B.V. DAVID[2]

(With six text-figures)

A new species of *Asialeyrodes*, viz. *A. indica* sp. nov. (from Tamil Nadu: Coimbatore, Kerala: Ambalamedu, Maharashtra: Bombay) is described and illustrated. This is the first report of the genus from India. Five new species of the new genus are described and illustrated. *Cockerelliella* gen. nov. (from India): *Cockerelliella dioscoreae* sp. nov. (from Tamil Nadu: Munchirai); *C. indica* sp. nov. (from Tamil Nadu: Munchirai and Kunnathoor); *C. meghalayensis* sp. nov. (from Meghalaya: Nongkhalaw); *C. quaintancei* sp. nov. (from Kerala: Ambalamedu); and *C. zingiberae* sp. nov. (from Tamil Nadu: Manalodai). Seven Malayan species described by Corbett in 1935 under the genus *Dialeurodes*, viz. *D. adinandrae*, *D. curcumae*, *D. kamardini*, *D. lumpurensis*, *D. psidii*, *D. rhodamniae* and *D. sembilanensis*, have been assigned to the new genus proposing new combinations.

INTRODUCTION

Corbett (1935) erected the genus *Asialeyrodes* for *A. lumpurensis* and *A. selangorensis* Corbett from Malaya with the former being the type species. Takahashi (1942) added two new species under this genus, viz. *A. euphoriae* Takahashi and *A. multipori* Takahashi from Thailand and proposed a new combination *A. maesae* (Takahashi) for *Pseudaleurolobus maesae* from Taiwan. In 1949 he described one more new species *A. corbetti* Takahashi from Riouw Islands. In the present paper the characteristic features of the genus *Asialeyrodes* are defined with the description of one new species forming the first report from India, and a genus *Cockerelliella* gen. nov. is described with five new species; new combinations have been proposed for seven species of *Dialeurodes* Cockerell described by Corbett (1935) from Malaya.

Asialeyrodes Corbett, 1935

Type species: *Asialeyrodes lumpurensis* Corbett, 1935. *J. F.M.S. Mus. 17:* 841-842, by monotypy.

Pupal case almost flat, broadly elliptical; marginal band narrow; submarginal area wide, separated by a suture-like line around the case. Dorsum without conspicuous pores or papillae; thoracic and caudal tracheal folds distinct. Vasiform orifice small, subcordate, not notched, without teeth; operculum similarly shaped and obscuring lingula. Orifice not surrounded by a trilobed area.

Asialeyrodes indica sp. nov. (Fig. 1)

Type area: South India: Coimbatore.
Type material: Holotype "one pupal case on slide, *Ervatomia coronaria*, south. India (Tamil Nadu) Coimbatore, B.V. David, 15 April 1968" In coll. B.V. David. Paratypes: 11 pupal cases on slides with same data as holotype, 5 slides, *Ervatomia coronaria*, south India (Kerala) Ambalamedu, R. Sundararaj, 28 July 1987, 9 slides, *Ervatomia coronaria*, Bombay (Maharashtra), R. Sundararaj, 18 March1989.
Diagnosis: This species resembles *A. multipori* Takahashi in shape and size but it differs by capitate nature of cephalic and first abdominal setae and in the structural features of the tracheal pore.

DESCRIPTION

Pupal case: White with little wax on the dorsal surface; broadly elliptical, very slightly constricted across the thoracic tracheal pores, broadest at the first abdominal segment region; 0.81-1.08 mm long and 0.62-0.87 mm wide; found on the under surface of leaves in large numbers.

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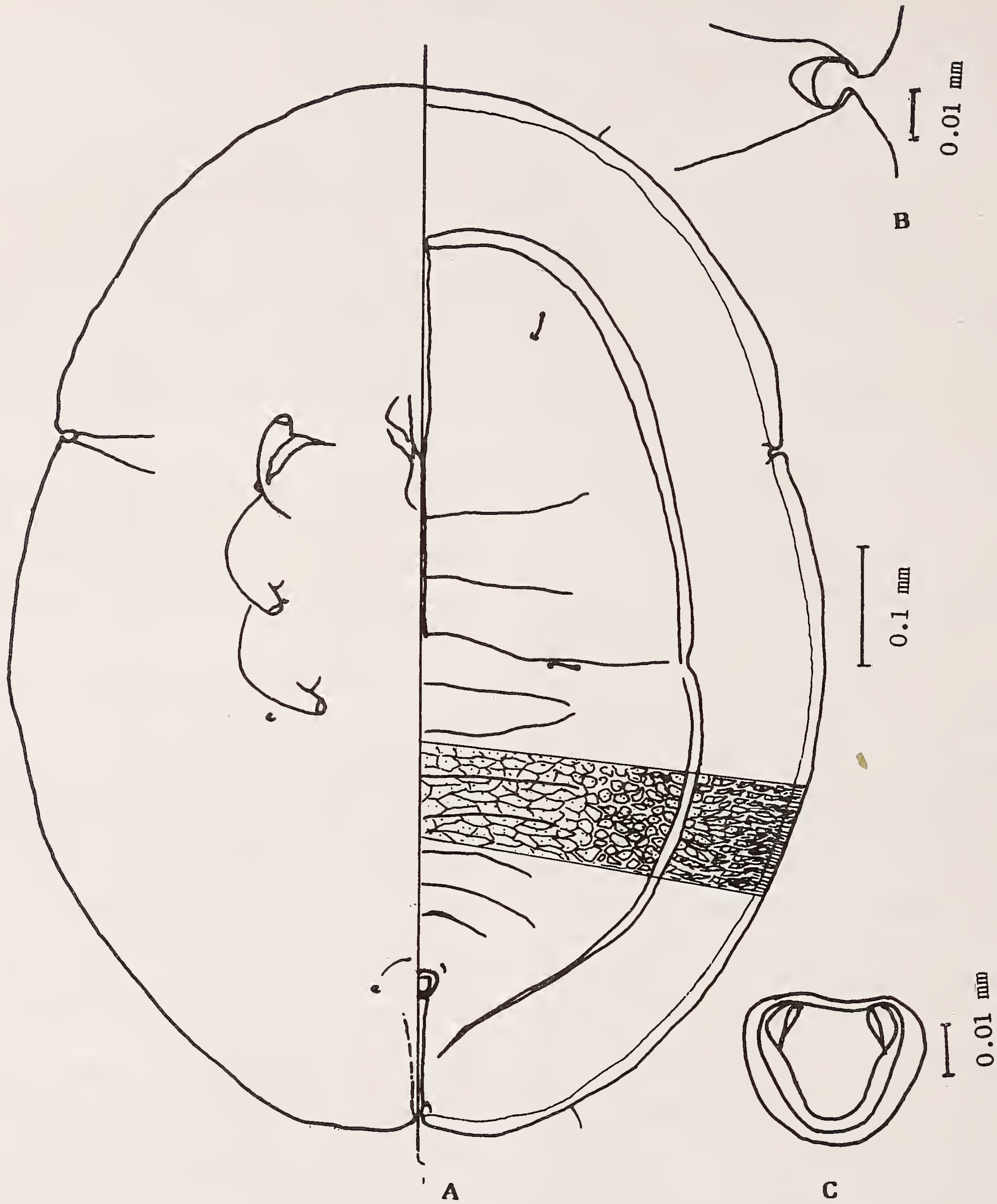

Fig. 1 *Asialeyrodes indica* sp. nov. A. Pupal case, B. Thoracic tracheal fold, C. Vasiform orifice.

Margin: Smooth with a narrow marginal band; anterior and posterior marginal setae respectively 22.5 and 20.0μ long; thoracic and caudal tracheal pores distinct with chitinised rim.

Dorsal surface: Four pairs of setae – cephalic setae capitate 17.5μ long, first abdominal setae capitate 22.5μ long, eighth abdominal setae cephalolaterad of vasiform orifice pointed 5 μ long, and submarginal caudal setae 10μ long. Dorsum with polygonal structures; submargin demarcated from the dorsal disc by a suture-like line around the case, 100-130 μ wide.

Vasiform orifice small, subcordate, wider than long 25-30 μ long and 30.0-37.5 μ wide, filling the orifice, obscuring the lingula. Caudal tracheal furrow distinct with polygonal markings and thoracic tracheal furrows not discernible.

Ventral surface: Paired ventral abdominal setae 30 μ long and 27.5 μ apart; thoracic tracheal folds distinct; caudal tracheal fold faintly discernible.

Cockerelliella gen. nov.

Type species: *Cockerelliella indica* sp. nov., on *Calophyllum* sp., Munchirai, 2 Aug.1987, Coll. R. Sundararaj.

Pupal case broadly elliptical; pores and folds distinct without stipples; caudal tracheal furrow distinct and thoracic tracheal furrow indistinct; submargin wide, separated from dorsal disc only on the cephalothorax by cephalothoracic fold or suture; submarginal setae present; dorsum with conspicuous pores and papillae; first abdominal setae wanting; longitudinal moulting suture reaching margin and transverse moulting suture reaching submargin. Vasiform orifice small, subcordate, notched at the caudal end; operculum similarly shaped filling the orifice and obscuring the lingula.

This new genus is close to *Asialeyrodes* Corbett but differs in the separation of submargin from dorsal disc only on the cephalothorax, in having conspicuous pores and papillae on dorsum, and caudal end of vasiform orifice being notched.

From the whiteflies collected and examined five species have been found to be new to science and assignable to this new genus. Further the critical study of the description of *Dialeurodes* spp. described by Corbett (1935) from Malaya has shown that *D. adinandrae*, *D. curcumae*, *D. kamardini*, *D. lumpurensis*, *D. psidii*, *D. rhodamniae* and *D. sembilanensis* are assignable to this new genus resulting in proposing new combinations.

Cockerelliella dioscoreae sp. nov. (Fig 2)

Type area: South India: Munchirai

Type material: Holotype one pupal case on slide, *Dioscorea alata*, south India (Tamil Nadu) Munchirai, R. Sundararaj, 3 August1987. In coll. B.V. David. Paratypes: 8 cases on slides with same data as holotype.

Diagnosis: This species resembles *Dialeurodes lumpurensis* Corbett in shape and by the differentiation of margin by a fold around the case but differs by the presence of distinct thoracic tracheal fold and by the absence of distinct tubercles near the legs and cephalothorax.

DESCRIPTION

Pupal case: White without secretion of wax; broadly elliptical, slightly constricted at the thoracic tracheal pore region, slightly narrowed at the posterior region, widest across the region of first abdominal segment; 0.66-0.88 mm long and 0.55-0.73 mm wide; found singly on the under surface of leaves.

Margin: Regularly crenulate, 21-24 crenulations in 0.1 mm; thoracic and caudal tracheal pores distinct with chitinised rim, marginal area differentiated by a fold around the case; margin incised by sutures; anterior and posterior marginal setae each 25 μ long.

Dorsal surface: Three pairs of setae – cephalic setae 12.5μ long, eighth abdominal setae 5 μ long, and submarginal caudal setae 5 μ long; first abdominal setae wanting. Dorsum tassellated

KEY TO INDIAN
SPECIES OF *Cockerelliella* GEN. NOV.

1. Submargin without papilla-like structures but with striations; thoracic tracheal pore region deeply invaginated with chitinised rim; caudal furrow not smooth 2
– Submargin with papilla-like structures but without striations; thoracic tracheal pore region indicated by slight invagination; caudal furrow smooth .... *quaintancei* nov. sp.
2. Prothorax, mesothorax and second abdominal segment without enlarged tubercles 3
– Prothorax, mesothorax and second abdominal segment each with a pair of enlarged tubercles .... *meghalayensis* sp. nov.
3. Pupal case 0.66-0.93 mm long and 0.55-0.78 mm wide; a submedian row of papilla-like structures on dorsum present 4
– Pupal case 0.94-1.19 mm long and 0.75-0.96 mm wide; a submedian row of papilla-like structures on dorsum absent .... *zingiberae* sp. nov.
4. Marginal area differentiated by a fold around the case; meso and metathoracic segments and first and eighth abdominal segments without brown patch .... *dioscoreae* sp. nov.
– Marginal area not differentiated by a fold around the case; meso and metathoracic segments and first and eighth abdominal segments with brown patch .... *indica* sp. nov.

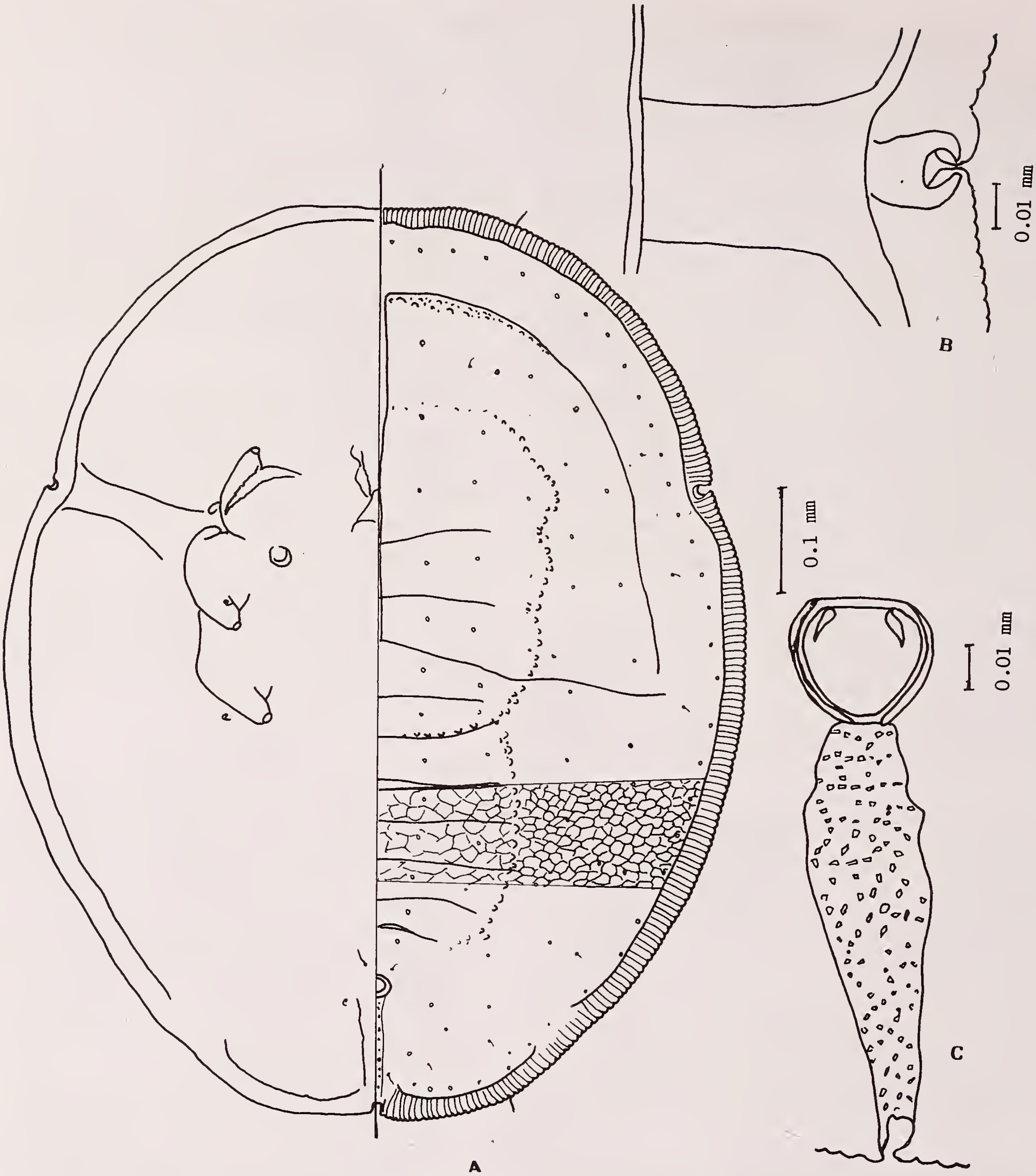

Fig. 2. *Cockerelliella dioscoreae* sp. nov. A. Pupal case, B. Margin and submargin, C. Vasiform orifice

with row of pores and porettes – a row on submargin, two rows on subdorsum, and two rows on submedian region of abdomen and three rows on submedian region of cephalothorax; a distinct row of crescent shaped papilla-like structures extending from laterad of vasiform orifice to the anterior end of cephalothorax, a few on the suture separating second and third abdominal segments; a row of seven setae on submargin, of which five are on abdomen and two on cephalothorax on each side.

Vasiform orifice subcordate, slightly notched at the caudal end, wider than long (25 x 30 μ); operculum similarly shaped, 17.5-20.0 μ long and 20.0-25.0 μ wide, filling the orifice and obscuring the lingula. Caudal tracheal furrow 92.5μ long with polygonal markings while thoracic tracheal furrow not indicated.

Ventral surface: Ventral abdominal setae cephalad of vasiform orifice 10 μ long and 42.5 μ apart. Thoracic and caudal folds distinct

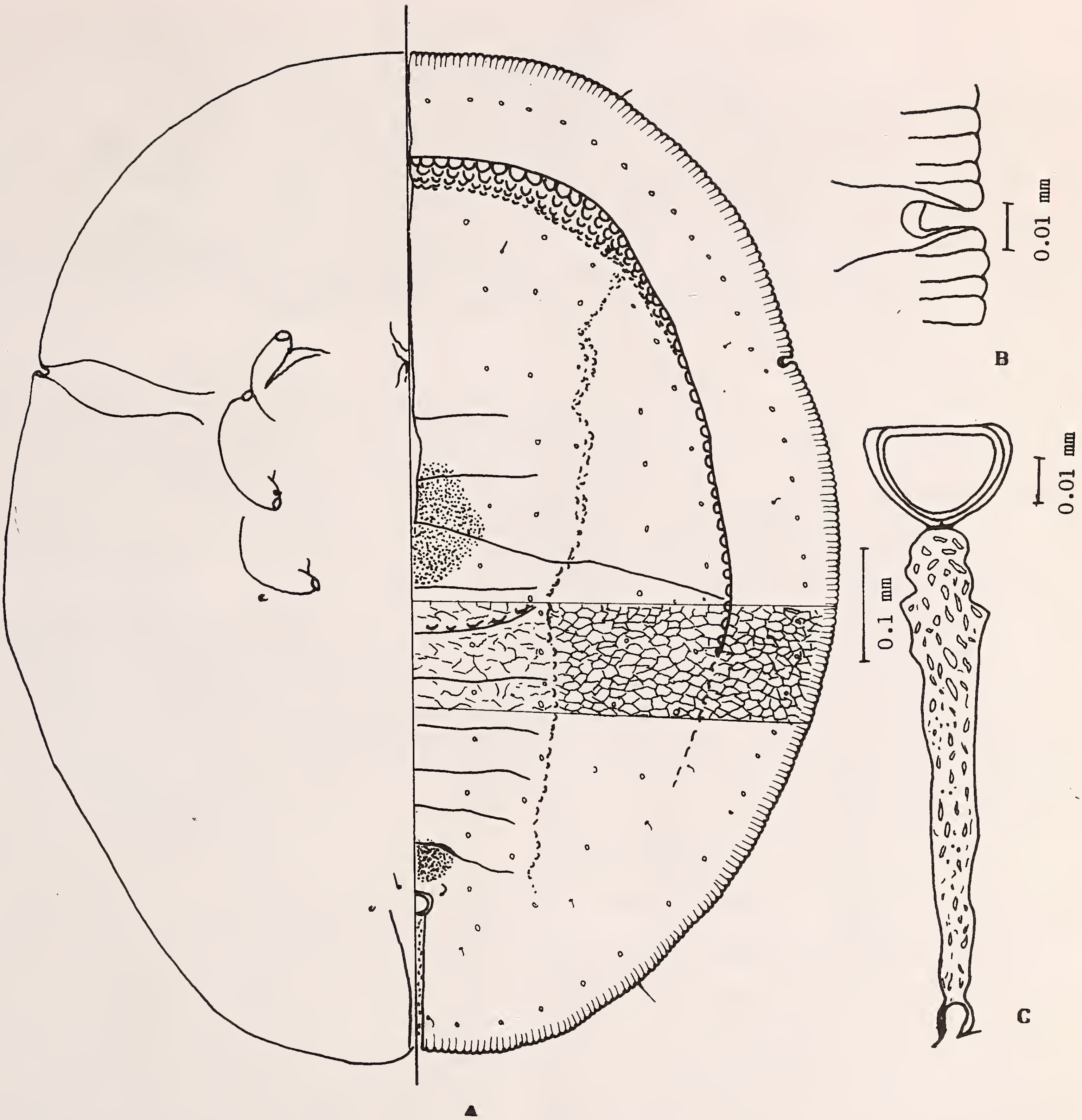

Fig. 3. *Cockerelliella indica* sp. nov. A. Pupal case, B. Thoracic tracheal fold, C. Vasiform orifice

without stipples or sculpturing.

Cockerelliella indica sp. nov. (Figs. 3)

Type area: South India: Munchirai.

Type material: Holotype one pupal case on slide, *Calophyllum* sp., south India (Tamil Nadu) Munchirai, R. Sundararaj, 2 Aug.1987. In coll. B.V. David. Paratypes: 2 pupal cases on slides with same data as holotype; 3 cases on slides, unidentified plant, Kunnathoor (Tamil Nadu), K. Regu, 25 Feb.1988.

Diagnosis: Resembles *Dialeurodes adinandrae* Corbett in shape and size but differs by the presence of median patches on eighth and first abdominal segment and pro- and mesothoracic segments, a distinct row of papilla-like structures on submedian area and by submargin with a row of setae.

Description

Pupal case: White, without wax; broadly elliptical, slightly constricted at the thoracic tracheal pore region, broadest at the first abdominal segment region; 0.75-0.93 mm long and 0.61-0.78 mm wide; found singly one or two per leaf on the under surface of leaves.

Margin: Regularly crenulate, 22-24 crenulations in 0.1 mm; caudal and thoracic tracheal pores distinct with chitinised rim; anterior and posterior marginal setae respectively 17.5 and 25 μ long.

Dorsal surface: Three pairs of setae – cephalic, and eighth abdominal setae each 2.5 μ long and submarginal caudal setae 5 μ long; first abdominal setae wanting; dorsum faintly tassellated with pores – submargin with a row, subdorsum with two rows, and submedian area with two rows on abdomen and three rows on cephalothorax, a distinct row of densely stained papilla-like structures extending from laterad of vasiform orifice to anterior end of cephalothorax; a few on the suture separating second and third abdominal segment and distinct papilla-like structures along the inner side of cephalothoracic fold distinct; submargin with seven pairs of setae 5 μ long of which 5 pairs on abdomen and 2 pairs on cephalothorax. Distinct brown patches present on the mesad of eighth abdominal, first abdominal, meso and metathoracic segments.

Vasiform orifice small, notched at the caudal end, subcircular, wider than long, 22.5-25.0 μ long and 32.5-35.0 μ wide; operculum similarly shaped, 17.5-20.0 μ long and 22.5-25.0 μ wide, filling the orifice and concealing the lingula. Thoracic tracheal furrows not indicated while caudal tracheal furrow indicated with polygonal markings, 105μ long and 10 μ wide.

Ventral surface: Paired ventral abdominal setae 15 μ long and 32.5 μ apart; thoracic and caudal tracheal folds distinct.

Cockerelliella meghalayensis sp. nov. (Fig. 4)

Type area: India: Nongkhalaw.

Type material: Holotype "one pupal case on slide, unidentified plant, India, (Meghalaya) Nongkhalaw, B.V. David, 1 October 1988". In coll. B.V. David Paratypes: 6 pupal cases on slides, with same data as holotype.

Diagnosis: This species runs close to *C. indica* sp. nov. in size and by the presence of submedian row of papilla-like structures on dorsum but distinct from it by the presence of distinct tubercles on cephalothorax and second abdominal segment.

Etymology: Named after Meghalaya in which Nongkhalaw is situated.

Description

Pupal case: White, without secretion of wax; broadly elliptical, slightly constricted at thoracic tracheal pore region and slightly narrowed at the caudal end, broadest at the first abdominal segment region; 0.75-0.88 mm long and 0.58-0.73 mm wide; found singly and scattered on the under surface of leaves.

Margin: Finely crenulate, 30-32 crenulations in 0.1 mm; thoracic and caudal tracheal pores distinct with chitinised rim; anterior and posterior marginal setae respectively 17.5 and 15.0 μ long.

Dorsal surface: Three pairs of setae – cephalic setae 12.5 μ long, eighth abdominal setae 5 μ long, and submarginal caudal setae 5 μ long; first abdominal setae wanting. Papilla-like structures present along the inner side of cephalothoracic fold; dorsum tassellated with distinct pores; submargin with a row, subdorsum with two rows, two rows on submedian area of abdomen, and three rows on submedian area of cephalothorax; a submedian row of papilla-like structures extending from laterad of vasiform orifice to the anterior end of cephalothorax with a few on the suture separating second and third abdominal segments; paired tubercles on prothorax, mesothorax and second abdominal segment on submedian area distinct; submargin with a row of seven pairs of setae, 5 μ long – five pairs on abdomen and two pairs on cephalothorax distinct.

Vasiform orifice subcordate, notched at the caudal end, wider than long, 27.5-30.0 μ long and 37.5-40.0 μ wide; operculum similarly shaped, 20.0-22.5 μ long and 27.5-30.0 μ wide, filling orifice and obscuring the lingula. Caudal furrow

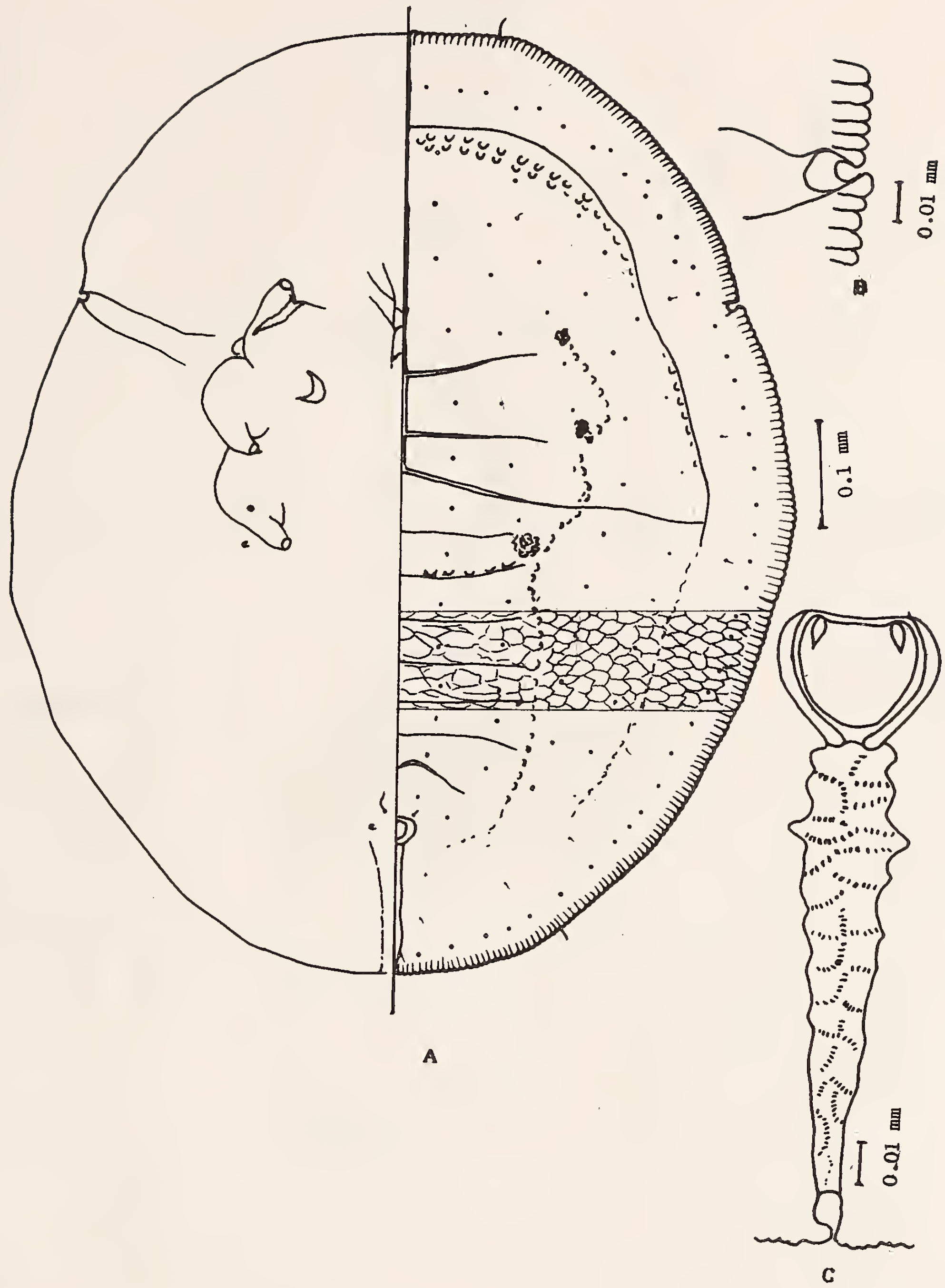

Fig. 4. *Cockerelliella meghalayensis* sp. nov. A. Pupal case, B. Thoracic tracheal fold, C. Vasiform orifice

prominent with dots, broader near the anterior end and narrowed towards the pore end.

Ventral surface: Ventral abdominal setae 12.5 μ long and 35 μ apart, thoracic tracheal folds distinct while caudal tracheal fold slightly indicated.

Cockerelliella quaintancei sp. nov. (Fig. 5)

Type area: South India: Ambalamedu

Type material: Holotype "one pupal case on slide, *Ailanthus* sp., south India (Kerala) Ambalamedu, R. Sundararaj, 30 July 1987". In coll. B.V. David. Paratypes: 3 pupal cases on slides with same data as holotype; 1 pupal case on slide, *Cordia* sp., south India (Kerala), Ambalamedu, R. Sundararaj, 29 July1987.

Diagnosis: This species resembles *Dialeurodes kamardini* Corbett by the presence of crescent markings on dorsum but differs in shape, size, short dorsal setae and absence of marginal sutures

Etymology: Named in honour of late A.L. Quaintance.

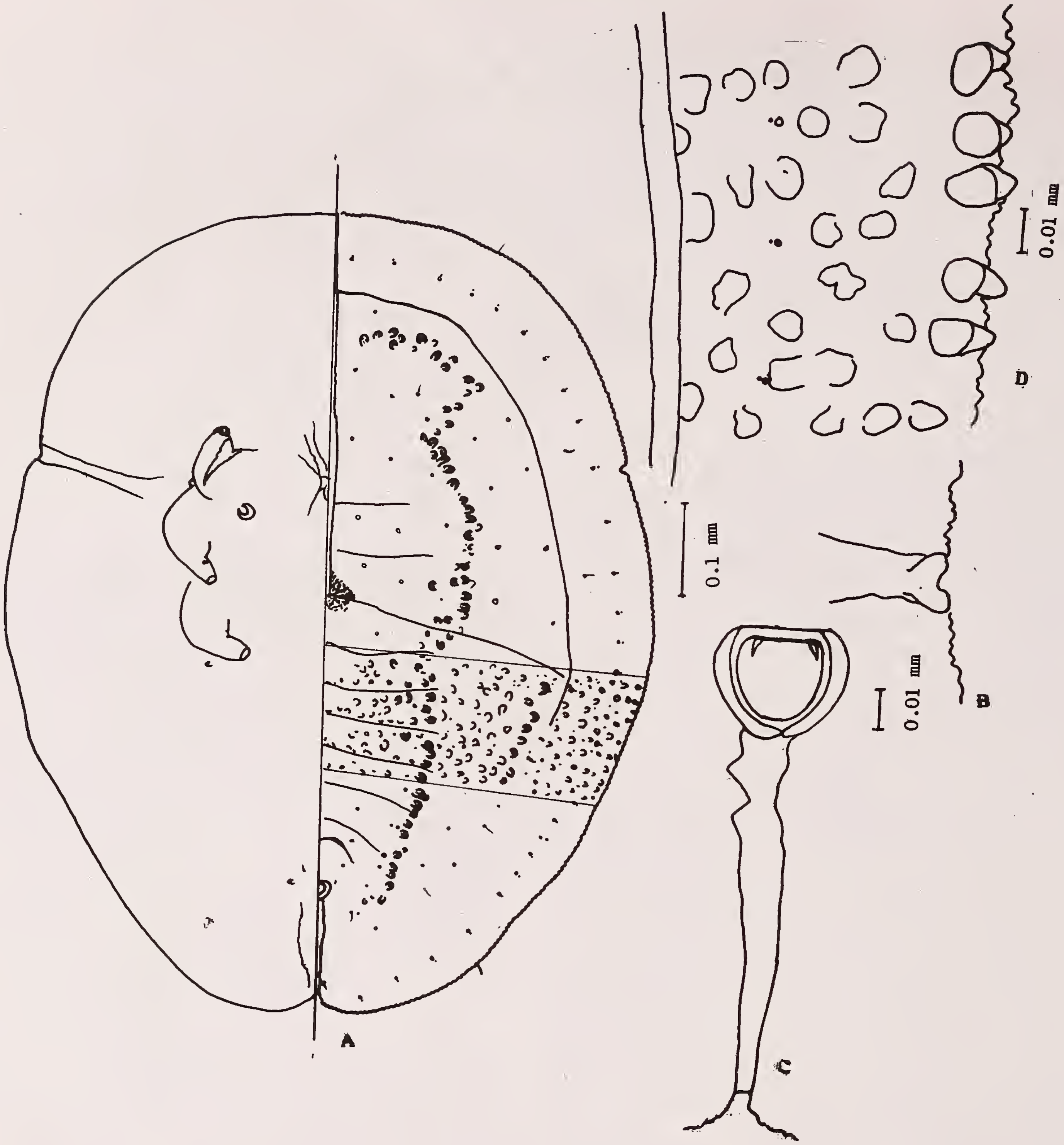

Fig. 5. *Cockerelliella quaintancei* sp. nov. A. Pupal case, B. Thoracic tracheal fold, C. Vasiform orifice, D. Margin and submargin.

Description

Pupal case: White, with wax secretion, broadly elliptical, slightly constricted at thoracic and tracheal pores, posterior part of abdomen slightly narrowed; 0.74-0.77 mm long and 0.59-0.63 mm wide; found singly on the under surface of leaflets.

Margin: Regularly crenulate, 28 crenulations in 0.1 mm; thoracic tracheal pore region slightly indented in the margin and caudal tracheal pore distinct; anterior and posterior marginal setae each 20 μ long.

Dorsal surface: Three pairs of setae – cephalic setae 15.0-17.5 μ long, eighth abdominal setae 15 μ long and submarginal caudal setae 7.5 μ long; first abdominal setae wanting. Dorsum with numerous papilla-like structures, a distinct submedian row of papillae extending from laterad of vasiform orifice to the anterior end of

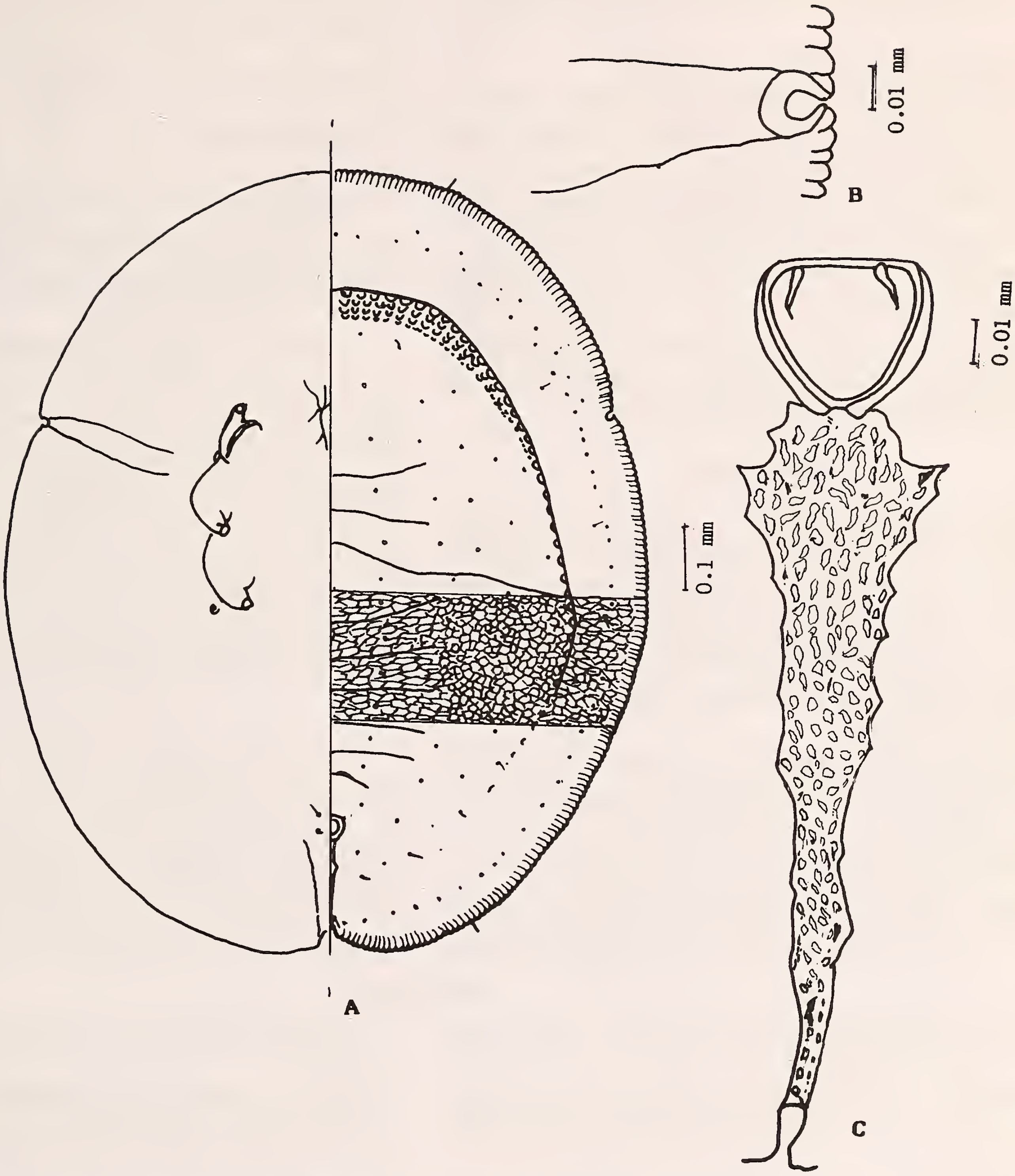

Fig. 6. *Cockerelliella zingiberae* sp. nov. A. Pupal case, B. Thoracic tracheal fold, C. Vasiform orifice

cephalothorax and rows of pores - submedian area with two rows on abdomen and three rows on cephalothorax, subdorsum with two rows and submargin with a row of pores. Seven pairs of setae 5 μ long on submargin – five pairs on abdomen and two pairs on cephalothorax. A light brown patch evident on the mesad of first abdominal and prothoracic segments.

Vasiform orifice subcircular, notched at the caudal end, 27.5-30.0μ long and 32.5-35.0 μ wide; operculum similarly shaped, 20.0-22.5 μ long and 22.5-25.0μ wide, filling the orifice; lingula concealed; caudal tracheal furrow distinct, 85 μ long and 75 μ wide without dots or sculpturing μ and thoracic tracheal furrows not discernible.

Ventral surface: A pair of ventral abdominal setae 10 μ long and 30 μ apart. Thoracic and caudal tracheal folds distinct without stipples.

Cockerelliella zingiberae sp. nov. (Fig. 6)

Type area: South India: Manolodai.
Type material: Holotype "one pupal case on slide, *Zingiber* sp., south India, (Tamil Nadu) Manalodai, R. Sundararaj, 4 August 1987". In coll. B.V. David – Paratypes: 8 mounted pupal cases, bearing the same details as of holotype.
Diagnosis: This species runs close to *Dialeurodes sembilanensis* Corbett in shape but differs considerably in size, and by the presence of papilla-like structures along the cephalothoracic fold and the absence of ring of submarginal spines.

Description

Pupal case: Pale yellow, with wax of uniform thickness all over the case; broadly elliptical, slightly constricted at thoracic tracheal pore regions, broadest across the first abdominal segment; 0.94-1.19 mm long and 0.75-0.96 mm wide, found singly one or two per leaf on the under surface of leaves.
Margin: Finely crenulate, 20 crenulations in 0.1 mm; thoracic and caudal tracheal pores distinct with chitinised rim; anterior and posterior marginal setae respectively 15 μ and 22.5 μ long.
Dorsal surface: Three pairs of setae – cephalic setae and eighth abdominal setae each 2.5 μ long and submarginal caudal setae 3 μ long; first abdominal setae wanting. Papilla-like structures along the inner side cephalothoracic fold, more on the anterior end; submarginal sutures evident; dorsum tassellated with rows of pores – submargin with a row, subdorsum with two rows and submedian area with two rows on abdomen and three rows on cephalothorax. Submargin with seven pairs of setae, 5 μ long – five on abdomen and two on cephalothorax.

Vasiform orifice subcordate, notched at the posterior end, wider than long (27.5-30.0 μ long and 37.5-40.0μ wide); operculum similarly shaped 22.5-25.0 μ long and 30.0-32.5 μ wide; filling the orifice and lingula concealed, caudal tracheal furrow distinct with polygonal markings and thoracic tracheal furrows indiscernible.
Ventral surface: Ventral abdominal setae 15 μ long and 40 μ apart; caudal and thoracic tracheal folds discernible without stipples.

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References

Corbett, G.H. (1935): Malayan Aleyrodidae. *J. fed. Malay. St. Mus. 17:* 722-852.

Takahashi, R. (1942): Some foreign Aleyrodidae (Hemiptera) IV. Species from Thailand and French Indo-China (Homoptera). *Trans. nat. Hist. Soc. Formosa 32:* 204-216.

Takahashi, R. (1949): Some Aleyrodidae from Riouw Islands (Homoptera). *Mushi. 20:* 47-53.

A NEW SUBGENUS OF *COELIOXYS* LATREILLE (HYMENOPTERA : APOIDEA : MEGACHILIDAE) FROM INDIA[1]

RAJIV K. GUPTA[2]

(With five text-figures)

A new subgenus *Tropicocoelioxys* (Type-species: *Coelioxys* (*Tropicocoelioxys*) *genoconcavitus* sp. nov.) of genus *Coelioxys* Latreille has been proposed. The diagnostic characters of the new subgenus are given, as also its affinities to subgenus *Melanocoelioxys* Mitchell and the description of type-species;. *genoconcavitus* sp. nov. has certain affinities with *C. confusus* Smith and *C. perseus* Nurse.

Tropicocoelioxys[3] subgen. nov.

Type-species of the subgenus: *Coelioxys* (*Tropicocoelioxys*) *genoconcavitus* sp. nov.

Diagnostic characters Subocellar area deeply punctured, flat; occipital margin at vertex incurved and carinate; lateral ocelli close to the occipital margin; genae neither narrowed above or below, almost completely traversed with a deep elliptical densely pubescent concavity, margined all along with distinctly elevated carina, extending from near the upper margin of eye up to the hypostome below; first segment of labial palp about half that of second in length; scutum humped anteriorly; carina of pronotal tubercle not elevated but spinose towards lateral side; scutellar surface sparsely 'pitted', posterio-median carina over projecting up to propodeum; axillae resembling scutellum in surfacial texture, spine short, do not cross the transverse line if drawn with the scutellar crest; concavity margin of basal tergum carinate; gradular groove on terga 2 and 3 interrupted medially or at the most quite shallow at mid line, bare; gradular groove on and tergites restricted laterally and distinctly margined anteriorly, with dense pubescence; in males fifth tergum with a preapical prominent spine at lateral extremities; 6th tergum with 4 acute spines at apex and 2 baso-lateral, all acutely produced; sternum 5 usually exposed.

The subgenus *Tropicocoelioxys* subgen. nov. reflects certain close relationship with Nearctic *Melanocoelioxys* Mitchell (type-species: *C. tolteca* Cresson) in respect of – scutum anterio-medially humped; sternum 5th in males exposed; scutellum with sparse punctures, crest usually produced over the metanotum and propodeum and subocellar area of face usually closely punctate and quite flat. However, the following characters of differentiation put both subgenera quite far and distinct – vertex margin slightly carinate; lateral ocelli equidistant from eyes and occipital margin; genae narrower than eye in lateral view, usually not constricted below in males and constricted on either side in females; genal area without concavity, at the most certain hypostomal excavation would be obscurely present; scutum smooth, impunctate medially; carina of pronotal tubercle prominently elevated; axillar dorsal surface compressed at spine and more or less recurved; concavity margin of basal tergum not carinate; foveal area of tergum 2 finely but deeply punctured; tergal grooves of all terga interrupted medially, distinctly fasciate and with defined anterior margin.

In Mitchell's key (1973, p. 28) to the subgenera of genus *Coelioxys* of the western hemisphere, subgenus *Tropicocoelioxys* can be suitably adjusted in between nos. 6 and 7 in close relationship to *Melanocoelioxys* Mitchell.

Coelioxys (Tropicocoelioxys) genoconcavitus[4] sp. nov. (Figs. 1-5)

MALE: Integument black with redness; abdomen, legs, tegulae and antenna with much redness (variation: integument totally black, as those of paratypes); punctures coarse and deep; on face, legs, tegulae fine and closer and dorsally at

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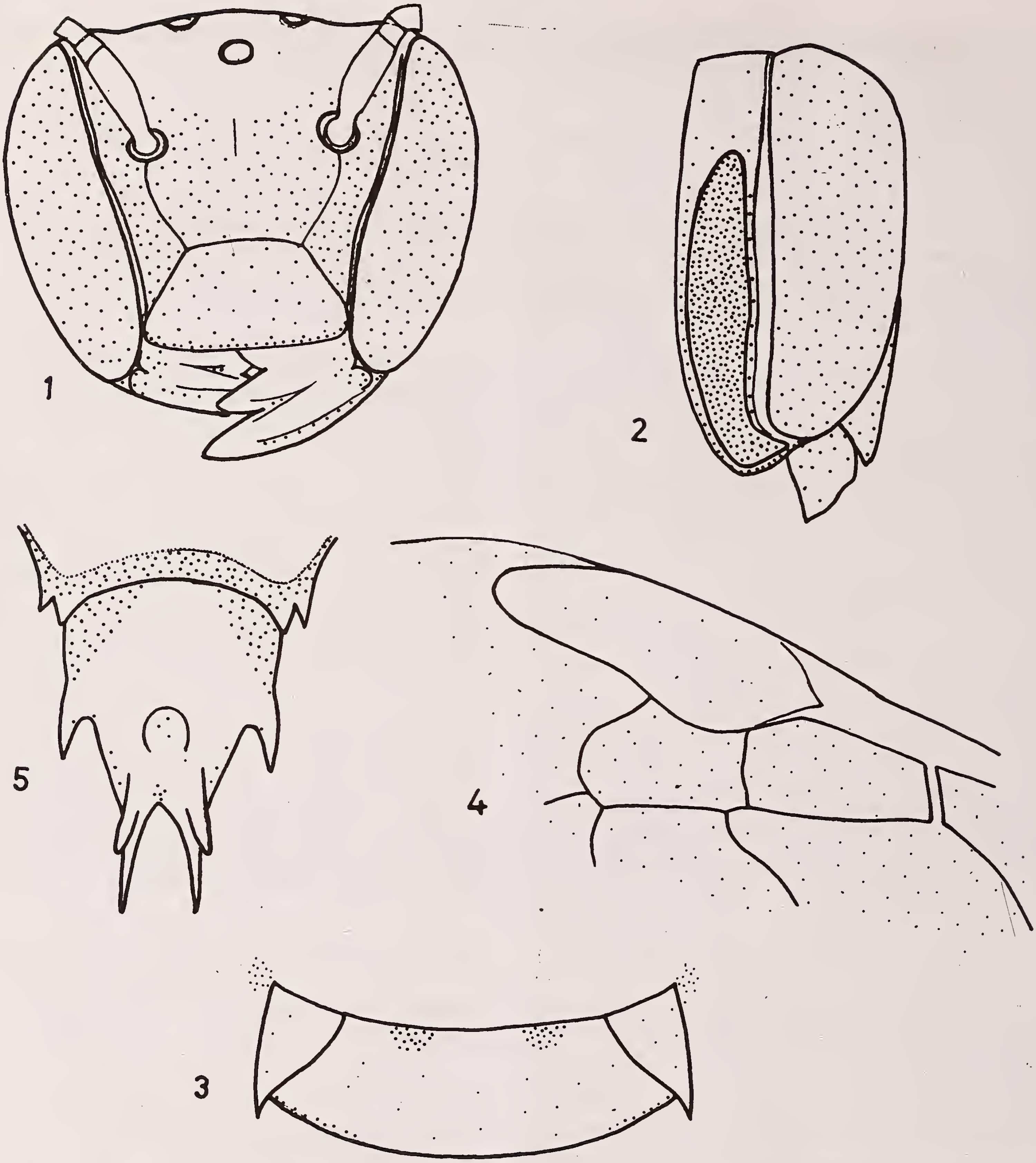
[3]Named after its record from the tropics (south India).

[4]Named after the prominent concavity at Genae.



Figs. 1-5: *Coelioxys* (*Tropicocoelioxys*) *genoconcavitus* sp. nov. 1. Head, front view 2. Head, lateral view 3. Scutellum and axillae; 4. Fore wing, anterior venation 5. Tergum 6th, dorsal view (dots indicate pubescence).

metasoma deeper but closer and ventrally shallow and sparse.

Pubescence white to pale, tarsal fringe golden; apical fasceae on terga 2-5 complete, usually all erect except the tergal and sternal fasceae, where it is ferruginous. Head about twice as wide as median length; face densely hairy; eyes strongly convergent below, hairy, inner margin with prominently elevated carina; clypeus flat, median length greater than basal width, apical margin transverse not angulated laterally and densely fringed; supraclypeus same as clypeus; parocular area deeply concave near antennal sockets; antennal sockets depressed dorso-laterally, equidistant

to each other, midocellus and clypeus, quite close to the eye margin; length of scape of antenna slightly greater than that of apical flagellar segment; subocellar area deeply punctured, flat with a fine midfacial line; lateral ocelli on slightly convex surface of vertex, distance to each other is less than to occipital margin and much less than to eye margin; occipital margin at vertex deeply incurved, depressed and strongly carinate; genal width less than eye width in lateral view, neither narrowed above or below, genal concavity broadly filling complete genal surface and with dense thick plumose hairs, not projecting beyond the carinate margins all around; occipital margin at gena distinctly carinate, carina of genal concavity and of occipital margin are distinctly separated by a deep but fine groove; excavated hypostomal area below genal concavity, transverse and with dense pubescence; mandibles red, tridentate, teeth quite robust, each with two prominent ridges running towards dentate margin; segment 2nd of labial palpi about twice that of first in length, joints of 2nd and angulated 3-4 with two coarse and two fine bristles; labrum almost equal in length and width.

Scutum slightly wider than median length, anteriorly humped; rest flat, deep punctures arranged in longitudinal striations, median and parapsidial lines fine but notaulices obscure; pronotal extensions below tegulae sharply carinate and terminate in an acute ridge, close to mesepisternal carina; mesepisternal carina (subdividing unsculputured anterior face with that of densely pubescent lateral face) itself is distinctly fasciate, followed by slightly bare longitudinal strip at lateral face of mesepisternite; scutellum sparsely 'pitted', posterior carina almost transverse, projecting completely over metanotum and propodeum, slightly upcurved medially; axillar surface resembling scutellum, spinose projection acute but short, not exceeding the transverse line if drawn at the level of scutellar crest; tegulae finely punctured and shining; forewings pale-hyaline, brownish near costal margin becoming pale fuscous towards apex, second recurrent vein is slightly further from base than the first, which is quite close to the apex of the second cuboital cell; fore coxae with a prominent spine; apices of metatarsi and tarsi produced anteriorly in fore legs, rest of the legs normal and unmodified.

Basal tergal concavity margin completely carinate; gradular groove of 2nd and 3rd terga quite shallow, unhairy, anterior margins not defined and much confined to lateral sides; on terga 4 and 5 gradular groove hairy and anteriorly defined; apical fasceae on terga 2 to 5 almost complete medially; rim areas on terga 4 and 5 quite wide; tergal foveae indistinct; tergum 5 with a prominently produced spine originating from the base of rim at extreme lateral sides; tergum 6 with 4 apical and 2 lateralo-basal spines, all acutely produced; apico-dorsal spines are slightly exceeded by their respective ventral pair in length, concavity medially at the base of dorsal spines quite deep; apical margin of terga 6 below deeply incurved and subapical surface shallowly concave in between the base of ventral pair of spines; 5 sternites exposed; first sternum acutely protuberent at base with a patch of hairs; sterna 1 and 2 with apical fasceae interrupted medially, rest with fasceae complete at their apical margins, rims slightly depressed on sterna 2 to 4; 5th sternite broadly evaginated medio-apically and densely pubescent.

Total length 9.0; median length and maximum width of face 1.8 and 3.5; F. wing length 7.0 (all in mm).

Female: Not known.

Material Examined: Holotype Male, Cubbon Park, Bangalore, 10 June1981; Coll. Rajiv K. Gupta. Paratypes 2 Males (on 11 and 12 June 1981 from same locality). All types presently with author, shall be submitted to NPC, Entomology Division, IARI, New Delhi in due course of time.

C. (T.) genoconcavitus sp. nov. is very distinct from all the known Indian species of genus *Coelioxys*. Not only any Indian but neighbouring as well as far territorial species do not possess the remarkable character of genal concavity; at the most hypostomal excavations are known to exist in several species the world over. However, *C.*

perseus Nurse (collected from Mount Abu) and *C. confusus* Smith (on record from Lucknow, Mussoorie and Pusa) seem to be close relatives of *genoconcavitus* in respect of 6 spines on apical terga in addition to upturned scutellar crest with *perseus* and many subgeneric characters leading up to subgenus *Melanocoelioxys* of *confusus* (I consider *confusus* can be suitably grouped under *Melanocoelioxys*). The major features which distinctly separate *perseus* from the new species are - rounded scutellar crest, spine of 5th terga short and blunt; all metasomal terga with lateral extremities spinose; shining and bare scutellum; sternum 5th not exposed in males and lack of genal concavity at cheeks.

Comparatively, *confusus* is much more close to *genoconcavitus*. However, following characters distinctly separate the former species from the new one – hypostomal excavation confined to extreme ventral area; mandible tridentate but teeth not so prominently produced, inner angle subacute; clypeal apical margin with 5 fine tubercles, surface convex; scutellar crest broadly rounded, smooth, not upturned medially; all terga with complete apical fasceae and 5th sternum partially exposed, surface somewhat bare.

ACKNOWLEDGEMENTS

I wish to express my gratitude to Dr R.L. Blinn (North Carolina State University), Dr Basilowsky (Musee Royal de L' Afrique Central – Tervuren, Belgium) and Dr S.I. Farooqi (IARI, New Delhi) for their sincere cooperation during this study.

REFERENCES

MITCHELL, T.B. (1973): A subgeneric revision of the bees of the genus *Coelioxys* of the Western Hemisphere. Contr. Deptt. Entomol. North Carolina State Univ., N.C. Raleigh, 129 p.

SOME NEW CHALCID PARASITOIDS (HYMENOPTERA:EULOPHIDAE) RECORDED FROM INDIA[1]

NIKHAT ARIFA[2] AND M.A. KHAN[3]

(With thirty-five text-figures)

Two eulophid genera: *Ginsiella* Erdos and *Olynx* Foerster have been recorded for the first time from India. Four new species, viz. *Diglyphus indicus, D. frontolatus*, *Ginsiella indica* and *Olynx indicus* are described in detail. Type material has been deposited in Zoological Museum, Aligarh Muslim University, Aligarh.

Genus *Diglyphus* Walker

Diglyphus Walker, 1844. Ann. Mag. Nat. Hist., 14: 409.

Type-species: *Cirrospilus chabrias* Walker, by monotypy.

There has been some confusion over the type species of the genus *Diglyphus*. Some publications carry the type-species as *D. poppaea* Walker, 1848. This error probably stems from the citation of *D. poppaea* as the type-species by Ashmead (1904: 372) and listed again in Gahan and Fagan (1923-45).

Gordh and hendrickson Jr. (1979) have solved the contraversy over the confusion of its type species by citing the earlier work of Walker (1844). In this case Walker (1844) wrote, "*Diglyphus chabrias*, *Cirrospilus chabrias*, *Ann. Nat. Hist.* i. 451. Alten Finmark". This is the earliest reference Gordh and Hendrickson Jr. could find to this name and from the context of the remainder of Walker's article they have declared it as a new combination. Thus *Cirrospilus chabrias* Walker no doubt should be the type-species of *Diglyphus* by monotypy.

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KEY TO THE INDIAN SPECIES OF THE GENUS *Diglyphus* WALKER BASED ON FEMALES

1. Fore wings hyaline 2
– Fore wings infuscated 4
2. Antennae uniformly dark brown 3
– Antennae dark brown with funicle segments and club white; body dark brown with golden reflections. .... *D. horticola* Khan
3. Body iridescent bluish-green with very fine reticulate sculpture; frontovertex with big punctures, wider than long, width about one-half the total head width; postocellar line almost two times as long as ocellocular; prominence between antennal sockets slightly more than one-fourth the width of frons between eyes; pedicel a trifle less than two times as long as wide; two anelli present; first funicle segment distinctly less than three times as long as wide .... *D. indicus* sp. nov.
– Body dark brown with very faint iridescent reflections except clypeal region which is yellowish brown, very finely sculptured; frontovertex smooth without punctures; frontovertex more than two times as wide as long, width distinctly more than half the total head width; postocellar line less than one and one-half times as long as ocellocular; prominence between antennal sockets less than one-fourth the width of frons between eyes; pedicel almost one and a half times as long as wide; three anelli present; first funicle segment distinctly less than two times as long as wide .... *D. frontolatus* sp. nov.
– Entire club white, funicle segments quadrate, subequal in size; stigmal vein longer than postmarginal vein..... .... *D. mandibularis* Khan
– Entire club uniformly brown except apex white; funicle segments longer than wide; postmarginal vein longer than stigmal vein .... *D. funicularis* Khan

The distinguishing characters of the genus have been given in detail by Peck *et al.* (1964) and Gordh and Hendrickson Jr. (1979). Khan (1985) recorded the genus for the first time from India. The generic characters suggested by him, viz. i) mandibles quadri to pentadentate, ii) maxillary and labial palpi two and one segmented respectively, iii) subgenital plate deeply concave, middle of anterior margin connected with the central notch of posterior margin by longitudinal groove, iv) first valvifers triangular; outer plates of ovipositor narrow at base, gradually widening posteriorly with a submarginal ridge along one half length of dorsal margin; third valvulae short, conical. These characters apply well to the species under study.

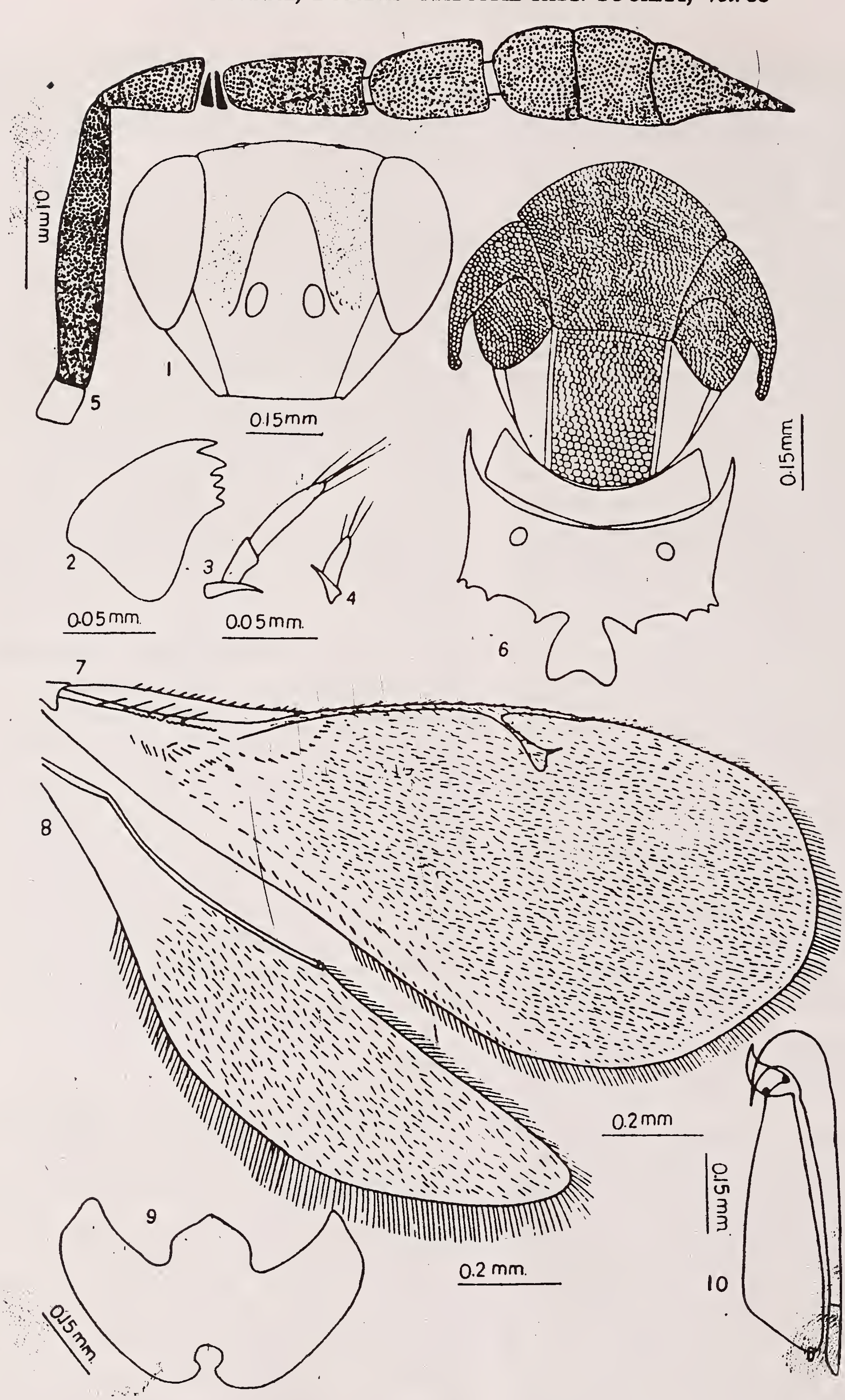
Three species are known from India, namely *D. horticola* Khan, *D. mandibularis* Khan, *D. funicularis* Khan. Two new species are describedhere and a key to the Indian species of genus has been framed.

Diglyphus indicus sp. nov. (Figs. 1-10)

Head (Fig. 1): Iridescent bluish-green, with very fine reticulate sculpture; frontovertex with big punctures; wider than long in facial aspect (0.66 : 0.52); frontovertex wider than long, width one-half the total head width (0.33: 0.66); ocelli arranged in obtuse angle triangle; postocellar line almost twice as long as ocellocular; antennae inserted well above the lower level of eyes; prominence between antennal sockets slightly more than one-fourth the width of frons between eyes (0.08:0.33); scrobe distinct; malar space longer than eye width (0.16 : 0.15); malar suture distinct; mandibles (Fig. 2) pentadentate with acute apices; maxillary (Fig. 3) and labial palp (Fig. 4) two and one segmented respectively.

Antennae (Fig. 5): Uniformly dark brown; scape cylindrical, less than six times as long as wide (0.20 : 0.035); pedicel a trifle less than twice as long as wide (0.085 : 0.045); distinctly shorter than first funicle segment; two anelli intervening between pedicel and first funicle segment; funicle two segmented; first funicle segment less than three times as long as wide (0.10 : 0.04); longer than second segment (0.08: 0.05); club three segmented, more than three times as long as wide (0.20: 0.06), longer than funicle segments together.

Thorax (Fig. 6): Iridescent bluish-green with very fine reticulate sculpture; posterior margin of pronotum with four pairs of strong setae; mesoscutum more than twice as wide as long (0.66 : 0.32), coarsely reticulate; parapsidal grooves complete, distinct throughout with a pair of bristle; scutellum with sublateral longitudinal grooves, wider than long (0.54:0.34); microreticulate sculptured, lateral area beyond scutellar grooves broadly reticulate with three pairs of bristles; posterior axilla reticulate; propodeal spiracles not contiguous with anterior margin of propodeum, both median and lateral



Figs. 1 - 10. *Diglyphus indicus*, sp. nov., female.
1. Head, frontal aspect, 2. Mandible, 3. Maxillary palp, 4. Labial palp, 5. Antenna, 6. Thorax, 7. Fore wing, 8. Hind wing, 9. Subgenital plate, 10. Ovipositor.

carinae present; mesopostphragma short.

Fore wings (Fig. 7): Hyaline, venation dark brown; more than twice as long as wide; costal cell broad, its upper side with a complete row of 15 hairs, its underside densely setose; basal vein with four straight setae and a tuft of five setae at its base; basal cell open, bare; speculum almost reduced; cubital vein straight; subcubital line of hairs starting from one third distance from base; submarginal vein (0.48) longer than margin vein (0.39), with five strong setae; postmarginal vein (0.16) distinctly longer than marginal vein (0.13); marginal fringe short.

Hind wings (Fig. 8): Hyaline, disc densely setose; more than four times longer than wide (1.4 : 0.32) with blunt apex; marginal fringe long.

Fore legs: Dark brown except apex of femora, basitarsus and basal half of second tarsal segment yellowish.

Middle legs: Coxa, trochanter and femora except basal and apical one fourthdark brown, rest of the leg yellowish with dark brown bands on basal and apical half of tibiae; tarsal segments 2-4 brown.

Hind legs: Coloration same as that of middle legs.

Abdomen: Iridescent bluish-green; longer than thorax; sub-genital plate (Fig. 9) broad, posterior margin with a notch in the middle; first valvifers triangular (Fig. 10) with basal and apical angles at different levels; third valvulae short, almost five times as long as wide, almost one-fourth the length of second valvifers (Fig. 10); outer plates of ovipositor (Fig. 10) shorter than second valvifers, narrow at base, broad at apex, basal three fourths with thickened dorsal margin; ovipositor slightly exserted, arising from basal one-third of abdominal venter.

Length of female: 1.55 mm.

Male : Not known.

Holotype: Female, INDIA; U.P.: Nainital, Kashipur ex. *Pseudonapomyza asiatica* Spencer (Diptera: Agromyzidae) on *Oryza sativa* Linn. (Graminae) 25 Sept.1984 (Nikhat Arifa).

Paratype: 30 Females same data as holotype.

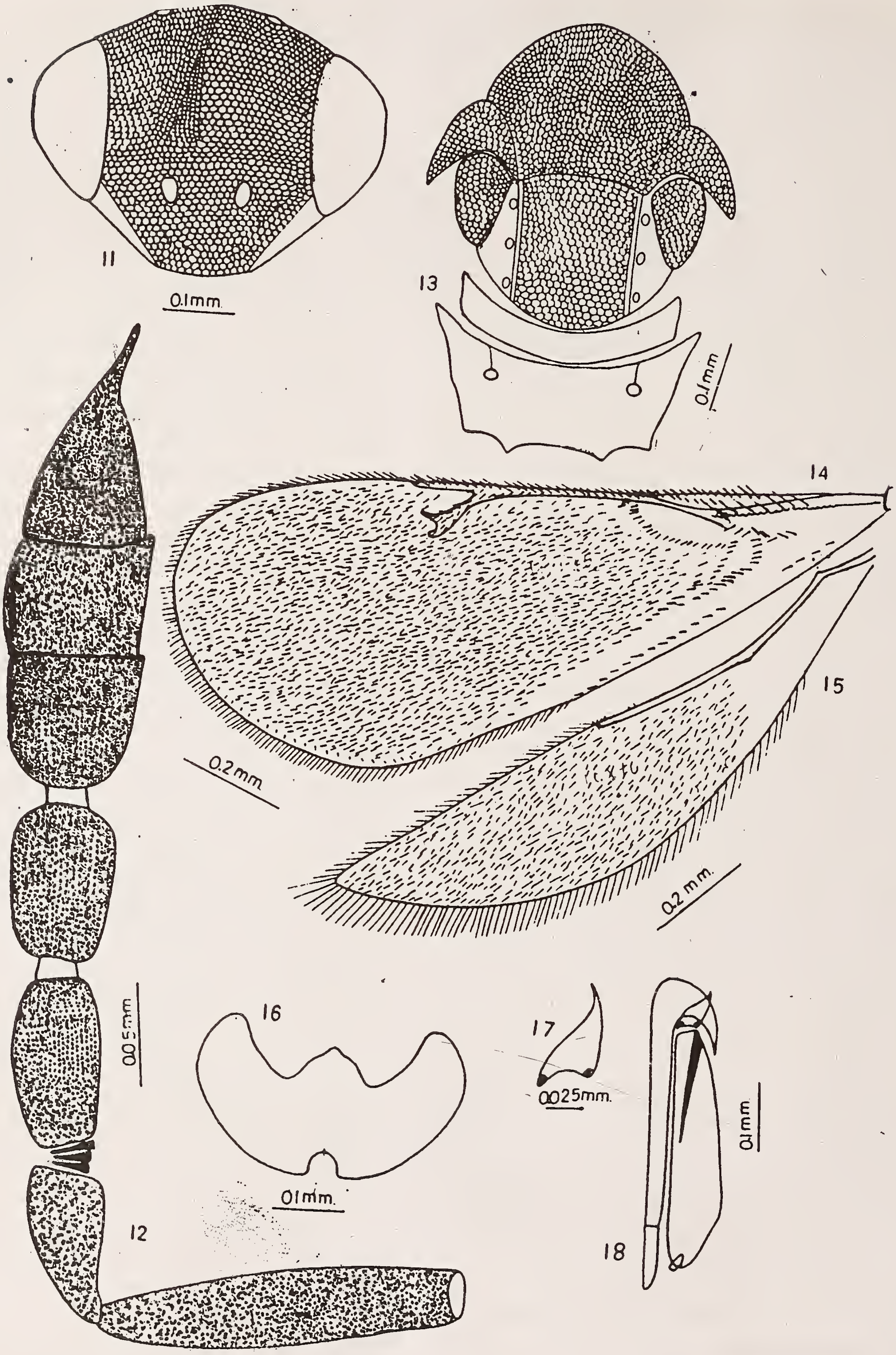
Diglyphus frontolatus sp. nov.(Figs. 11-18)

Head (Fig. 11): Dark brown with very faint iridescent reflections except clypeal region which is yellowish brown; very finely sculptured; wider than long in facial view (0.49 : 0.37), frontovertex more than twice as wide as long, width distinctly more than half the total head width (0.29 : 0.49); ocelli arranged in obtuse angle triangle, postocellar line less than one and one-half times as long as ocellocular; antennae inserted well above lower level of eyes; prominence between antennal sockets less than one-fourth the width of frons between eyes (0.08 : 0.29); scrobes distinct, short, smooth and polished; malar suture distinct; malar space longer than eye width; mandibles pentadentate with sharp apices; maxillary and labial palp two and one segmented respectively.

Antennae (Fig. 12): Uniformly brown; scape cylindrical, less than five times as long as wide (0.175 : 0.04); pedicel long, almost one and a half times as long as wide (0.065 : 0.04), distinctly shorter than first funicle segment; three anelli intervening between pedicel and first funicle segment; funicle two segmented, first funicle segment distinctly less than two times as long as wide (0.08 : 0.045), longer than second segment (0.075 : 0.05); club three segmented, more than three times as long as wide (0.22 : 0.07), distinctly shorter than funicle and pedicel combined.

Thorax (Fig. 13): Dark brown with faint iridescent reflections, with very fine reticulate sculpture; posterior margin of pronotum with six strong setae; mesoscutum more than two times wider than long (0.44 : 0.21), coarsely reticulate; parapsidal grooves complete, distinct throughout, with pair of bristles; scutellum wider than long (0.31:0.21), shorter than mesoscutum, microreticulate, sublateral longitudinal grooves well distinct, lateral area beyond scutellar grooves broadly reticulate with three pair of bristles; posterior axillae reticulate; propodeal spiracles not contiguous with anterior margin, both median and lateral carinae present; mesopostphragma short.

Fore wings (Fig. 14): Hyaline; venation dark brown; densely setose, almost two and a half times longer than wide; costal cell rather broad, its upperside with a complete row of nine hairs and its



Figs. 11 - 18. *Diglyphus frontolatus* sp. nov., female.
11. Head, frontal aspect, 12. Antenna, 13. Thorax, 14. Fore wing, 15. Hind wing, 16. Subgenital plate, 17. First valvifer 18. Ovipositor.

underside with a row of seven small hairs; basal vein pilose; basal cell open, bare; speculum very narrow and closed below; cubital vein strongly sinuate upwards where it joins the basal vein; subcubital line of hairs broken for a short distance, about one-third of distance from base; submarginal vein (0.42) longer than marginal vein (0.35) with seven strong setae; post-marginal vein (0.11) shorter than stigmal vein (0.13); marginal fringe short.

Hind wings: (Fig. 15): Hyaline; disc densely setose; more than four times longer than wide (1.25 : 0.28) with acute apex; marginal fringe long.

Fore legs: Coxa, trochanter and femora except apical one fourth dark-brown, rest of the leg infuscated; tibial spur very short.

Middle legs: Coxa, trochanter and femora except apical one fourth dark brown, rest of the leg yellowish with dark brown bands on basal and apical half of tibiae, last tarsal segment brownish.

Hind legs: Coloration same as that of middle leg.

Abdomen: Dark brown with white complete transverse bands on the dorsum, longer than thorax; subgenital plate broad, posterior margin with a notch in the middle (Fig. 16); first valvifers triangular (Fig. 17) with basal and apical angles at different levels; third valvulae short, less than four times as long as wide, one-fourth the length of second valvifers (Fig. 18); outer places of ovipositor (Fig. 18) slightly shorter than second valvifers; ovipositor slightly exserted, arising from basal one- third of abdominal venter.

Length of female: 1.4 mm.

Male: Not known.

Holotype: Female, INDIA, U.P. Lakhimpur Kheri, Palia ex. *Liriomyza taraia* Garg (Diptera : Agromyzidae) on *Vicia sativa* Linn. (Leguminosae) 15 Aug. 1984 (Nikhat Arifa).

Paratype: 20 Females (same data as holotype).

Ginsiella Erdos

Ginsiella Erdos 1951, *Acta. biol. Hung.*, 2 (1-3): 174-175. Type-species: *Ginsiella triarticulata* Erdos.

The genus *Ginsiella* was proposed by Erdos (1951) for the species *Ginsiella triarticulata* Erdos. The genus is characterised by the presence of complete parapsidal grooves, deep throughout; abdomen petiolate; spur of hind tibiae small, funicle in female with three segments; frontal cavity not limited by ridge dorsally; scutellum with two distinct sublateral grooves. Some new generic characters are suggested which will further facilitate the identification of the genus from closely allied ones, viz. mandibles bidentate with blunt teeth; maxillary (Fig. 20) and labial (Fig. 21) palpi one segmented each; pronotum with anterior margin deeply concave in the middle, anterolateral arms long and narrow, posterior margin much convex, bearing two pairs of long setae; ovipositor concealed, arising from the apical one-third of abdominal venter; first valvifer triangular (Fig. 27) with basal and apical angles at different level, second valvifers (Fig. 27) of uniform width; third valvulae rudimentary or absent; outer plates of ovipositor narrow at base, widened at apex, densely setose.

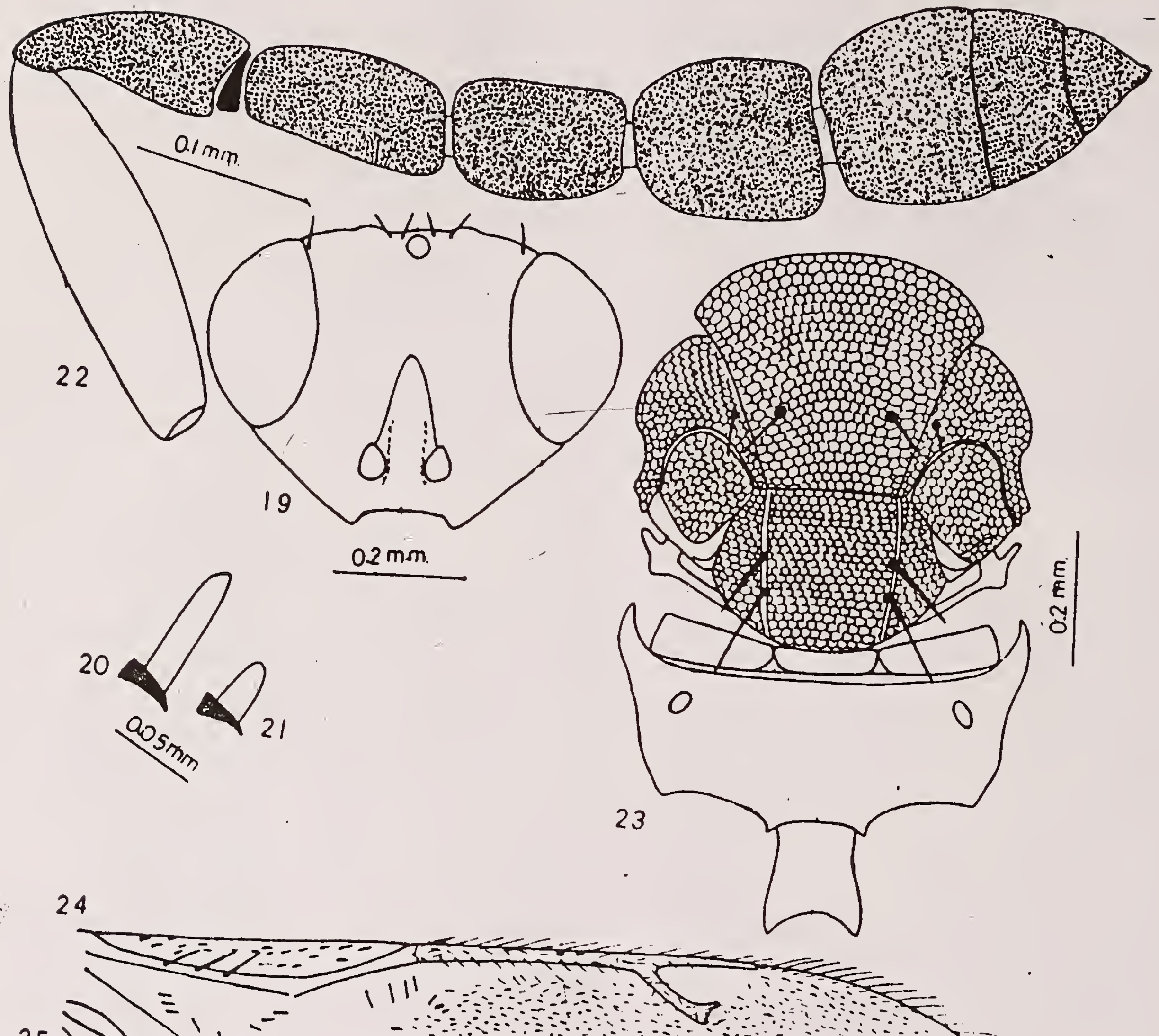
The genus is recorded for the first time from India. In the present work a new species *Ginsiella indica* is described and a key has been framed to distinguish it from *G. triarticulata* Erdos as follows.

1. Frontovertex punctate, very wide, distinctly more than one-half total head width; scape flattened, less than three times as long as wide; pedicel short, almost as long as first funicle segment; funicle segments transverse; segments subequal in size; club two segmented, distinctly longer than preceding two funicle segments combined.................. *G. triarticulata* Erdos

– Frontovertex smooth, wider than long, width less than one- half head width; scape cylindrical, less than four times as long as wide, pedicel longer than first funicle segment; funicle segments elongated, first funicle segment two times as long as wide, second almost one and a half times as long as wide, third segment slightly longer than wide; club three segmented, shorter than preceding two funicle segments combined .... *G. indica* sp. nov.

Ginsiella indica sp. nov. (Figs. 19-27)

Head (Fig. 19): Dark brown except clypeal region light brown, non-iridescent; moderately setose; wider than long in facial view (0.62 : 0.43); frontovertex wider than long, smooth, width less than one-half the total head width (0.28 : 0.62); ocelli



Figs. 19 - 27. *Ginsiella indica*, sp. nov., female.
19. Head, frontal aspect, 20. Maxillary palp, 21. Labial palp, 22. Antenna, 23. Thorax, 24. Fore wing, 25. Hind wing, 26. Part of fore, middle and hind leg, 27. Ovipositor.

white, arranged in obtuse angle triangle, post-ocellar line almost equal in length to ocellocular; frontal fork with arms obtusely diverging; eyes dark, bare; malar space longer than eye width (0.2 : 0.16); malar sutures absent; antennae inserted below lower level of eyes; prominence between antennal sockets less than one-fourth the width of frons between eyes; mandibles bidentate with blunt teeth; maxillary (Fig. 20) and labial palpi (Fig. 21) one segmented each.

Antennae (Fig. 22): Uniformly brown except scape which is yellow; 8 segmented excluding a ring segment; scape cylindrical, less than four times as long as wide (0.22 : 0.06); pedicel long, more than twice as long as wide (0.13 : 0.16), longer than first funicle segment; funicle three segmented, first funicle segment twice as long as wide (0.12 : 0.06), second almost one and a half times as long as wide (0.09 : 0.065), third segment slightly longer than wide (0.1 : 0.09); club three segmented, less than twice as long as wide (0.19 : 0.11), shorter than preceding two funicle segments combined.

Thorax (Fig. 23): Dark brown with metallic reflections; pronotum with anterior margin deeply concave in the middle, anterolateral arms long and narrow, posterior margin much convex, bearing two pairs of long setae; parapsidal furrows well developed, each parapside with a seta; mesoscutum with hexagonal reticulate sculpture, less than twice as long as wide (0.6 : 0.35), with two setae; scutellum with fine reticulate sculpture, short, wider than long (0.32 : 0.23), with four strong setae; surface of propodeum slightly roughened, both median and paraspiracular carinae present; propodeal spiracle not contiguous with anterior margin.

Fore wings (Fig. 24): Hyaline, less than three times as long as wide (2.16: 0.82); prestigma smoothly joining sub-marginal to marginal vein; costal cell broad, densely setose; basal cell with few setae; basal vein with three setae; cubital vein sinuate; submarginal vein (0.74) longer than marginal vein (0.54); postmarginal (0.22) less than one half of marginal vein; stigmal vein (0.16) shorter than postmarginal vein; marginal fringe spaced by a distance equal to one-fourth their length.

Hind wings (Fig. 25): Hyaline, more than four times as long as wide (1.5: 0.35) with apex tapering; marginal fringe almost one-third the wing width, spaced by a distance equal to one-fifth their length.

Legs (Fig. 26): Yellowish except hind coxaé black on greater part and femora with infuscation on dorsal margin.

Abdomen: Dark brown with a yellow patch on dorsum; longer than thorax; ovipositor concealed, arising from the apical one-third of abdominal venter; first valvifers triangular (Fig. 27), with basal and apical angles at different levels; second valvifers (Fig. 27) of uniform width; third valvulae (Fig. 27) rudimentary or absent; outer plates of ovipositor narrow at base, widened at apex (Fig. 27), densely setose.

Length of female : 1.51 mm.

Male: Not known.

Holotype: Female INDIA, U.P., Nainital, Rudrapur ex. Larva of *Calycomyza humeralis* (v. Roser) (Diptera: Agromyzidae) on *Conyza japonica* Less. 20 April 1983 (Nikhat Arifa)

Paratype: One female same data as holotype.

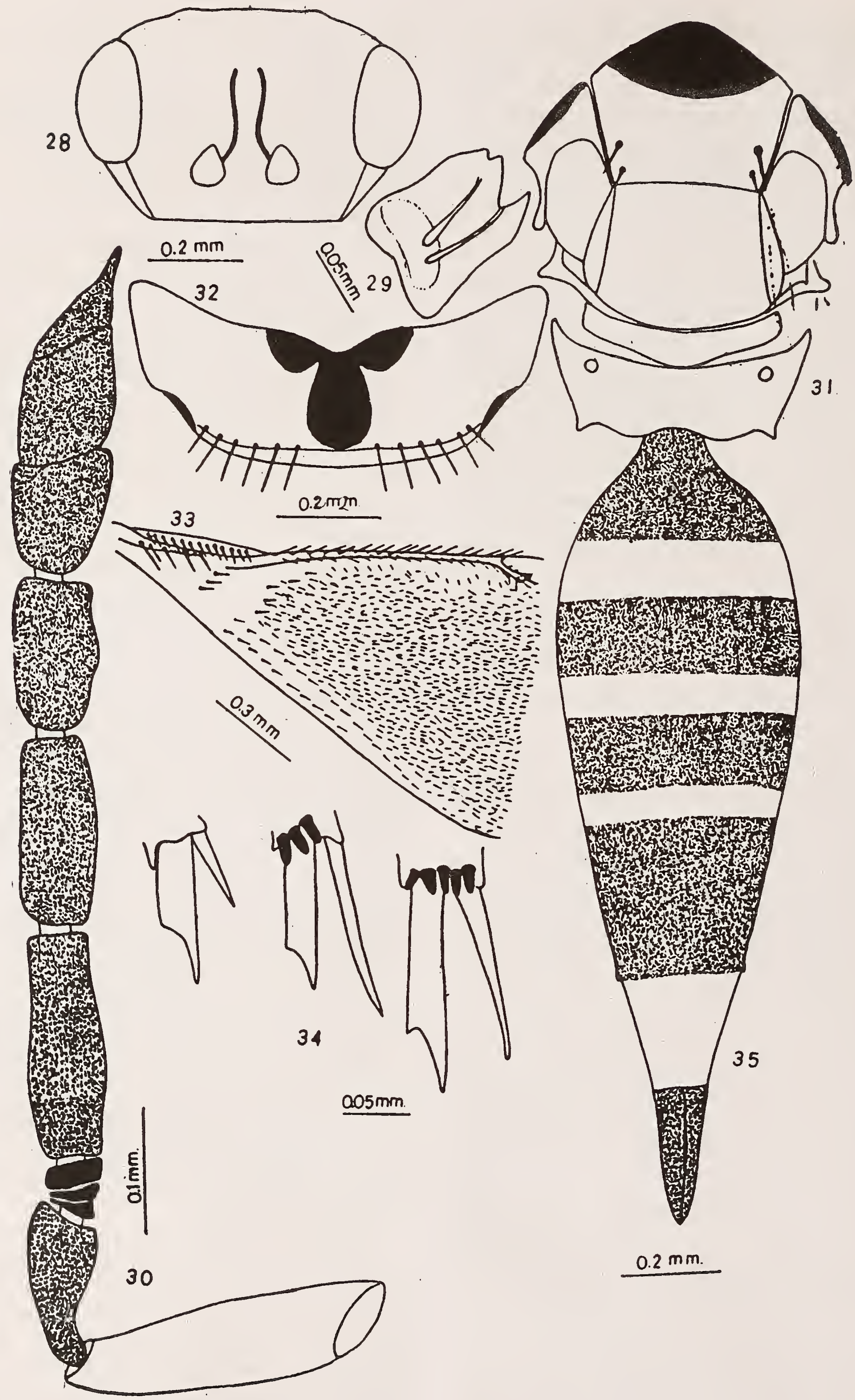
Genus olynx Foerster

Olynx Foerster, 1856. *Hym. Stud.,* 2: 74 (Type species: *Ichneumon gallarum* Linne).

Ashmead (1904) erected *Ophelinoideus* to include one Japanese species, *japonicus* Ashmead, without giving generic definition. Subsequently, Girault (1917) pointed out a similarity between *Ophelinoideus* and *Olynx*, describing some generic characters of the former. Kamijo (1976) studied the types of *O. japonicus*, which belonged to *Olynx.*

Kamijo (1976) while redescribing *Olynx japonicus* (Ashmead) has formulated its generic characters which can be summed up as: antennae with three funicle segments; scutellum without longitudinal grooves; middle tibial spur very long, as long as the first tarsal segment; abdomen sessile.

The genus is recorded for the first time from



Figs. 28 - 35. *Olynx indicus,* sp. nov., female.
28. Head, frontal aspect, 29. Mandible, 30. Antenna, 31. Thorax, 32. Pronotum, 33. Part of fore wing venation, 34. Part of fore, middle and hind leg, 35. Abdomen, attached with thorax..

India and a new species is described.

Olynx indicus sp. nov. (Figs. 28–35)

Head (Fig. 28): Yellowish with infuscation on frontovertex; much wider than long in facial view (0.67 : 0.4); frontovertex slightly more than two times as wide as long, width distinctly more than half the total head width (0.4 : 0.67); ocelli pale yellow, arranged in obtuse triangle; length of postocellar line almost two times as great as ocellocular; eyes red, bare; antennae inserted on the lower level of eyes; prominence between antennal sockets less than one-fifth the width of frons between eyes (0.09 : 0.42); malar space slightly shorter than eye width (0.12 : 0.13); malar suture distinct; mandibles (Fig. 29) tridentate with sharp apices; maxillary and labial palpi each one segmented.

Antennae (Fig. 30): Brownish except scape yellowish with dorsal margin infuscated; eight segmented excluding three ring segments; scape slightly flattened, less than four times as long as wide (0.24 : 0.07); third anellus greatly transverse and most conspicuous; pedicel two times as long as wide (0.12 : 0.06), distinctly shorter than first funicle segment; funicle three segmented, segments 1-3 drastically decreasing in length distad; first funicle segment longest, almost two and a half times as long as wide (0.16 : 0.065), second segment two times as long as wide (0.13 : 0.065); third shortest, distinctly longer than wide (0.105 : 0.07); club three segmented, more than three times as long as wide (0.22 : 0.07), shorter than preceding two funicle segments together.

Thorax (Fig. 31): Yellowish except pronotum with a brown patch in the middle, its anterior and lateral margins with small infuscated spots; mesopraescutum with a large brown patch, lateral margins of parapsides, lateral sides of scutellum, metanotum and propodeum infuscated; posterior margin of pronotum with submarginal ridge bearing six pairs of setae (Fig. 32); mesoscutum more than two times as wide as long (0.65 : 0.31); parapsidal furrows well developed; mesopraescutum bearing two bristles at each lateral margin without median longitudinal groove; scutellum wider than long (0.34:0.29), with four setae, broadly rounded at apex and without submedian grooves; propodeum with a well developed carina.

Fore wings (Fig. 33): Hyaline, more than two times as long as wide (2.15 : 0.94), broadly rounded at apex; costal cell short, with 13 long setae; basal vein with a row of three setae; basal cell completely bare; speculum narrow and open below; cubital vein straight; submarginal vein (0.46) short, with five long setae directed backward; marginal vein very long (0.82) densely setose; postmarginal vein rudimentary, stigmal vein (0.12) less than one-seventh the marginal vein; marginal fringe short.

Hind wings: Hyaline, almost five times as long as wide; marginal fringe short.

Legs (Fig. 34): Honey yellow except hind coxae infuscated; apical rim of mid tibiae with a row of three stout pegs, tibial spur very long, distinctly longer than basitarsus; apical rim of hind tibiae with a row of five stout pegs; tibial spur slightly shorter than basitarsus.

Abdomen (Fig. 35): Yellowish, except dorsum

TABLE 1

DIFFERENCES BETWEEN *O. japonicus* (ASHMEAD) AND *O. indicus* SP. NOV.

Body dark bluish green with a strong bronzy tinge especially on scutellum and dorsellum, clypeus blackish brown.	Body yellowish with infuscation on frontovertex, pronotum with a brown patch in the middle, abdomen yellowish except dorsum with transverse brown bands.
Pedicel a little longer than broad.	Pedicel twice as long as wide.
First funicle segment twice as long as broad, second segment much shorter than first; third segment slightly shorter than second.	First funicle segment almost two and a half times as long as wide, second segment twice as long as wide, third shortest, distinctly longer than wide.
Middle tibial spur fully as long as first tarsal segment.	Middle tibial spur very long, distinctly longer than first tarsal segment.

with transverse brown bands; very long, more than two times the length of thorax; ovipositor exserted, arising from base of abdominal venter; first valvifers almost semicircular with basal and apical angles in one plane; third valvulae long, one-third the length of second valvifers.

Length of female: 2.4 mm.

Male: Not known.

Holotype: Female, INDIA, U.P., Mussoorie, Chakrauta (9000′) ex. Lepidopterous leaf mine (unidentified) on wild plant, 4 May 1980 (Nikhat Arifa)

Paratype: 2 females (same data as holotype).

Species *O. indicus* differs from *O. japonicus* (Ashmead) as shown in Table 1.

ACKNOWLEDGEMENTS

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REFERENCES

BATRA, R.C. AND SANDHU, G.S. (1981): Differential population of citrus leaf-miner and its parasites on some commercial citrus cultivars. *J. Res. Punjab agric. Univ. 18: 170-176.*

BOUCEK, Z. (1965b): Synonymic and taxonomic notes on some Chalcidoidea (Hymenoptera) CAB international Wallingford, U.K. pp. 584-758 .

ERDOS, (1951): Eulophidae novae. *Acta. biol. Hung. 2 (1-3)*: 174-175.

FOERSTER, A. (1856): Hymenopterologische studien II Heft 1-152.

GORDH & HENDRICKSON JR. (1979): New species of *Diglyphus*, a world list of the species, taxonomic notes ·and a key to the new world species of *Diglyphus* and *Diaulinopsis* (Hymneoptera : Eulophidae). *Proc. Ent. Soc. Wash. 81(4):* 666-684.

KAMIJO (1976): Notes on Ashmead's and Crawford's types of Eulophidae (Hymenoptera : Chalcidoidea) from Japan. *Kontyu, Tokyo. 44(4):* 482-495.

KHAN, M.A. (1985): Eulophid parasites (Hymenoptera : Eulophidae) of Agromyzidae in India: *J. Bombay nat. Hist. Soc. 82 (1):* 149-159.

KHAN, M.Y. & SHAFEE, S.A. (1980): Taxonomic studies as some Indian Eulophid parasites (Hymenoptera : Chalcidoidea). *J. Bombay nat. Hist. Soc. 76:* 324-334.

PECK, O., BOUCEK, Z. & HOFFER, A. (1964): Keys to the Chalcidoidea of Czechoslovakia (Insecta : Hymenoptera): *Mem. ent. Soc. Canad. 34:* 120.

WALKER, F. (1844): On the species of Chalcidites inhabiting the Arctic region. *Ann. Mag. nat. Hist. 14:* 407-410.

WALKER, F. (1848): List of the specimens of hymenopterous insects in the collection of the British Museum, Part II, Chalcidites, Additional species. Newman, London.

MISCELLANEOUS NOTES

1. BURROW STRUCTURE IN RELATION TO HOARDING HABIT OF *RATTUS ARGENTIVENTER* IN TWO HABITATS

Rattus argentiventer is by far the most predominant rodent in rice fields in Indonesia. We studied the burrow structure and the extent of hoarding in upland areas (700 m above sea level) at Desa Cilember-Cisarua, Bogor and in lowland areas (150 m above sea level) at Desa Sindangbarang-Ciomas, Bogor. The data (Table 1) reveal that the main burrow entrance of *Rattus argentiventer* in upland areas is situated on dikes at a height of 38.55 cm, 38.2% of the dike height) whereas it is at 25.58 cm (at 46.5% of dike height) in lowland areas. The difference between the two is significant (t 0.05, d.f. 30). The average length of burrows of upland *R. argentiventer* is 64.66 cm whereas those in lowland areas measure 77.05 cm (Table 1). This difference in length of burrows in two habitats may be correlated with their hoarding behaviour.

R. argentiventer in lowland areas on an average hoards much more rice (42.8 g) than those in the upland areas (27.0 g, t 0.01, d.f. 24). This may be the reason why the burrows of rats living in lowland areas are longer.

TABLE 1

POSITION OF BURROWS OF *Rattus argentiventer* AT TWO DIFFERENT ELEVATIONS

Parameter	Lowland area	Upland area
Average (range)		
Height of the dike (cm)	55	11
	(23-107)	(45-142)
Height of main burrow entrance compared with the height of the dike (%)	46.51	38.17
	(20-82.76)	(16.67-92.54)
Length of burrows (cm)	77.05	64.66
	(52-208)	(30-110)
Diameter of main burrow entrance (cm)	7.43	8.46
	(5-10.5)	(5.5-11.5)
Food hoarded in the burrow (g)	42.79	27
	(7-139)	(3-73)

July 4, 1991 IBNU MARYANTO

2. OCCURRENCE, STATUS AND BREEDING OF *PODICEPS CRISTATUS* (LINN.) AND *FULICA ATRA* LINN.

This note deals with four aspects relating to the great crested grebe *Podiceps cristatus*: status and distribution, breeding records in Kutch and Saurashtra (it perhaps breeds in other areas of Gujarat too, but so far no information is at hand), the behaviour of a breeding pair (studied at random), its interaction with other waterbirds — particularly the coot *Fulica atra* — and in addition the records of the coot nesting in Kutch.

Since *P. cristatus* was first recorded in Kutch in May (1965, *JBNHS 62* : 551-53), we have regularly come across two to six birds mostly on irrigation dams, except in the years when these dams were either dry or had very little water owing to the paucity of rainfall or complete drought. A quarter of a century or so ago the great crested grebe was considered a very rare and irregular winter visitor to these parts. Neither Geoffrey Archer nor Dr Salim Ali (during his surveys in 1943-44 and subsequent visits over the years) had recorded it. This points to the likelihood that the populations of the great crested grebe have increased in their distributional areas in, if not the whole, at least a part of the palaearctic region; and hence perhaps the spill-over has started coming fairly regularly to Kutch and Saurashtra. The position is likely to be the same in the neighbouring areas of Rajasthan and Sind in Pakistan, wherever conditions are favourable. However, this latter possibility could only be proved through systematic observations. Some of these birds which visit us stay on throughout the year and a few of them carry out their nesting activities. Thus this grebe can now be considered partly resident.

Towards the end of the hot weather of 1965 one of us (H.) was informed by the late K.S. Narsinhji, that he saw a half-grown young with a pair of *P. cristatus* in the Rudramata Dam (Bhuj environs). This was the first breeding record for this area. Taej Mundkur and Rishad Parvez reported the breeding of this waterbird in Saurashtra in 1984 (*JBNHS 83:* 429-431). NNB saw

small chicks early in 1989 on Dhonsa jheel (*c.* 6 km north-west of Bhuj). When we went there on 14 January, in connection with the Asian Waterbird Count, we came across a pair with four chicks which were somewhat smaller than the dabchick. The total number of great crested grebe present on the jheel was 9, including the chicks. The other adults present there showed no signs of breeding. There were quite a few duck species, other waterbirds and 400 coots which formed the majority among the birds present.

This jheel has been deepened and widened during recent years, having the deepest portion towards the high bank to the west, in the middle and extending a bit to the east. The rest of it is shallow. The circumference of Dhonsa jheel is *c.* 5 km and there are thin patches of reeds in the middle and a thick belt of reeds, broken here and there, all around the periphery.

The most interesting fact about nesting *P. cristatus* was that they bred quite outside the known breeding period — June to August. If the incubation period of this species of 28 days were to be considered, the nesting activities must have begun in November, and the full clutch of eggs of this pair is likely to have been completed by end of November. Later on, in the beginning of the hot weather, two other pairs were seen by NNB to be building nests in the thin patch of reeds in the middle of the jheel, but they appeared to be left unfinished at the time of our visit there again on 7 April. This time eight *P. cristatus* were present along with about six coots.

The latest breeding record (observation by NNB) of this grebe was in Vala khavas jheel, *c.* 5 km west of Bhuj, on the Mandvi road. Once again NNB was the first to make the discovery. All three of us went there on 30 July 1989 and found the *P. cristatus* pair in full nuptial plumage, with the male displaying in front of the female, facing her with small strands of reeds in his bill which he brought up from below the surface of the water every now and then. No response from the female was noticed.

The male was also seen to deposit some strands of reeds in a nest located on the edge of a thin patch of reeds. The female swam about a bit, or remained stationary, quite close by. On the evening of 5 August the female sat in the nest, and the male frequently dived down to collect nesting materials which were deposited in the nest, and the female arranged the same in the nest. H visited the jheel again on 11 August and found the almost completed nest abandoned. The pair had shifted to another site, again on the outside edge of a thin patch of reeds near the main bank of the jheel to the north, overgrown with a thick impenetrable growth of *Prosopis chilensis*.

Here on the morning of 15 August, H found only the male carrying the nesting material and just dumping it on the nesting site; the female kept swimming some distance away. A pair of coots with small chicks was present nearby and another pair was building its nest in the middle of a patch of reeds next to the one in which the grebes were constructing theirs. One of the coots aggressively chased the male *P. cristatus* once as he approached his nest, and he in his turn, went for the coot with neck outstretched and wings partly raised, but did not drive home the attack.

After this, very often, when the male grebe swam away to collect nesting materials, a coot would come and take away strands of reeds from the nest under construction and deposit them in its own nest! It was interesting to study the interaction between these two species of waterbirds in the limited area of this small jheel (circumference of *c.* 2 km), which is surrounded by a wide belt of *Prosopis chilensis* particularly thick on the main bank to the north and east, and thinning out to the south and west. There are mainly three gaps through which the edge of the water could be approached, a narrow one near the overflow, another one a few metres away to the left (cattle and other livestock come down to drink water here), both situated on the eastern side, and the third gap on the west which has old worn-out steps leading to the water with some space to the left for animals to drink. Birdwatching can properly be done mostly through these gaps.

We theorised that the grebes gave up their first nest owing to the interference of the coots and this theory seemed to be correct; for on the next day (16th) H found the second nesting site abandoned too. This time the *P. cristatus* pair were actively bringing nesting materials which they just dumped on the site without climbing up into the reeds. The male brought long strands of reeds while the female was seen taking shorter lengths and also some other vegetation which was hardly visible through an 8 x 30 pair of binoculars at a distance of *c.* 175 m.

On 5 September H found the female sitting in the nest in the evening. The male swam around in the jheel and occasionally dived into the water to fetch nesting materials which were taken to the nest, and the female arranged them with her bill. No coots were observed near the site of the nest this time. On 11 September the male sat in the nest in the morning and the female

remained close by, almost touching the nest. NNB saw chicks on 17 September. The next day we saw the pair on the western side of the jheel and as the male preened the feathers of his back and wings, three very small chicks got momentarily pushed off into the water, but soon clambered back onto the male parent's back.

The female kept on swimming and constantly diving down for food (what looked like tadpoles) which was fed to the chicks, going close to the male who remained stationary, carrying the chicks on his back. The heads of a couple of chicks were clearly visible above the top edge of the wings of the male. The jheel was not visited till 27 October, when H went there. He found the pair of *P. cristatus* swimming apart. The male was accompanied by one young bird, the female by three. Thus four chicks were raised which at this time were slightly less than half grown. They were roughly a month-and-a half old, for they possibly hatched out between 12 and 17 September.

Apart from the above breeding records, NNB also noted the breeding of the great crested grebe on Devisar tank and Kansvati dam this year, which points to the breeding of this grebe on a wider scale in Kutch. There appears to be no special preference for large or small water bodies for nesting. The only prerequisite, as far as we have been able to study the breeding behaviour of this bird, is obviously deep water in which it can dive to obtain food and nesting material, and thin patches of reeds for nesting. The nests are located almost on the edges of the patches of reeds from which they could look all round. We also noticed that during the shared incubation the male was invariably seen on the nest in the day time (till late afternoon) while the female took over from the late afternoon, or evening, onwards.

The coot was purely a cold weather visitor till recently in Kutch, though sporadic breeding has been recorded in Saurashtra, the earliest being Dharmakumarsinhji's (*JBNHS 46:* 724), but at first NNB, and some days later both he and SNV (12 October 1986) saw a pair of *F. atra* with small chicks below Lair dam, *c.* 11 km east of Bhuj; and again at the same location on 6 November 1988. Thereafter they noted a nest of a pair and one more pair with nearly fully grown young on 31 October 1989 in Ratnal village tank. The earlier breeding this year of *c.* 3 + pairs on Vala khavas jheel has already been mentioned in connection with the breeding pair of *P. cristatus* above. We also observed pairs of coots breeding at Devisar tank, thus proving that this waterbird has now established itself in limited numbers as a nesting species in Kutch too.

Large numbers of coot visiting us – outnumbering all other waterfowl – are now a common feature on all manner of waterbodies during the cold weather. Some of these birds stay behind, or are permanent residents, in suitable habitats. Though normally a docile bird, the coot develops an acute sense of territorial possessiveness and (contrary to Dharmakumarsinhji's observations) it attacks its own kind as well as other species that intrude into its domain.

It builds a nest the size of which is quite out of proportion to its own body-size. Owing to this its need for nesting materials is quite large, and so whenever opportunity comes its way, it does not hesitate to supplement its own collections by pilfering from other species' nests. This trait of *F. atra* was clearly seen by us at Vala khavas jheel. The nesting site preferred is inside a thin clump of reeds.

Besides *P. cristatus* and *F. atra* there were 4 ± pairs of the little grebe *Podiceps ruficollis* nesting at the Vala khavas jheel. It was interesting to note in the restricted area of this small water body that although these grebes also had an acute sense of territory, and quite actively defended their own boundaries against encroachment of their own kind, they never made any attempts to venture into the spheres of influence of the bigger waterbirds, which in their turn took no notice of these smaller birds.

M. K. HIMMATSINHJI
S.N. VARU
N.N. BAPAT

December 12, 1989

3. OCCURRENCE OF WHITE OR LONGTAILED TROPIC-BIRD *PHAETHON LEPTURUS* ON THE SOUTH-EAST COAST OF INDIA

Mandapam and its neighbouring islands (9°17'N; 79°8'E) form an important wintering ground for migratory waders and terns in south India. Because of its geographical situation (very close to Sri Lanka) some interesting pelagic birds like the petrel, skua and noddy tern were recorded from this area (Balachandran in press). One more interesting record of a pelagic bird is now of the white tropic-bird *Phaethon lepturus* from

Rameshwaram island.

On 1 April 1989, at Rameshwaram near the Ramanathaswamy temple, I saw pair of white birds that looked like terns with yellow beak and long tail, soaring over the temple tower. The two much elongated, central tail feathers drew my attention immediately. I watched the birds for ten minutes through a pair of binoculars, while they were trying to land on the temple tower. Each of their three attempts was thwarted by the blue rock pigeons residing on the tower. After the failure to land they flew for some distance and again came towards the tower for landing. I therefore had sufficient time to watch the birds in flight and note the field characters. Later the birds were identified as the white tropic-bird.

The white tropic-bird differs from the closely related short-tailed tropic-bird (which also has white streamers) by the yellow bill and lack of barring on the back; the latter has a bright coral red bill and barring on the back. The other important characters noticed were the broad black band on the wing, black primary tips, black tarsus and feet. When it was trying to land on the tower the flight was pigeon-like. The two birds were always seen together. The next day a trip was made to the same place to see the birds, but they were not noticed in the vicinity.

Though there is no authentic sight record from India, this species is frequently recorded from the Sri Lanka coast, where, according to Henry (1971), it is a fairly regular north-east monsoon visitor in small numbers. Hume (1888) in Ripley (1982) recorded this species as a straggler at Cachar in Assam. Ripley (1982) described it as a straggler in Andaman island, but it was not recorded elsewhere from India. Hence the occurrence of the bird at Rameshwaram island is noteworthy. It is interesting that, though the bird is a north-east monsoon visitor to Sri Lanka, here it occurred in summer.

January 6, 1990 S. BALACHANDRAN

REFERENCES

BALACHANDRAN, S. (In press): Interesting bird records from Mandapam and neighbouring islands, Tamil Nadu. *J. Bombay nat. Hist. Soc.*

HENRY, G.M. (1971): A guide to the birds of Ceylon. Oxford University Press, Bombay.

RIPLEY, S.D. (1982): A synopsis of the birds of India and Pakistan. 2nd ed. Bombay Natural History Society, Bombay.

4. OCCURRENCE OF THE INDIAN SHAG *PHALACROCORAX FUSCICOLLIS* STEPHENS IN KERALA

According to Salim Ali (BIRDS OF KERALA, 1969, p. 20) the Indian shag *Phalacrocorax fuscicollis* "possibly occurs in Kerala, as it does in Ceylon and elsewhere in peninsular India." But this species had not been authentically recorded from this area ever since.

While watching birds at Kattampally (11°55'N, 75°20'E) on 15 November 1981, I noticed a bird among a group of 14 little cormorants *Phalacrocorax niger* larger in size though similar in appearance. Closer examination showed that the bird had a dark brown bill, more slender and longer than that of the little cormorant, and black plumage which appeared scaly on the wings and back. The yellow gular skin was also observed.

This bird was identified as the Indian shag *Phalacrocorax fuscicollis* Stephens in non-breeding plumage. In subsequent years more birds were found here. On 15 January 1989, 4 Indian shags were observed, perched on a tiny islet, among little cormorants, pintail ducks, garganey etc.

K.K. Neelakantan writes that in the Vernay Scientific Survey of the Eastern Ghats (Whistler and Kinnear, 1930-37, *JBNHS* : 34-39) it was said that the Indian shag had not been recorded south of Vedanthangal (Tamil Nadu).

July 19, 1989 C. SASHIKUMAR

5. UNUSUAL BREEDING SITE OF NIGHT HERON *NYCTICORAX NYCTICORAX* (LINN.)

The night heron *Nycticorax nycticorax* invariably prefers densely foliaged trees for roosting as well as nesting. At Keoladeo National Park, Bharatpur, the night herons normally nest in a dense cluster of babul (*Acacia nilotica*) trees near Malar gate. Only in stray cases does a nest or two of the night heron occur with the nests of white ibis *Theskiornis aethiopica* and herons in the main, comparatively open, heronry on babul trees.

In 1986, I found a very unusual heronry, purely of night herons, in the backwaters of the Chambal approximately 10 km upstream of Jawahar Sagar dam and barely 500 m from Kota-Rawatbhata road, 41 km south of Kota (25°06'N, 75°43'E). Here night herons bred in the open, without any camouflage or cover at all, on dry stumps of trees. What once used to be a thickly vegetated valley before the construction of this dam in the late 1960s, is now a vast stretch of water with remnants of trees jutting out here and there as dead and decaying stumps. It is on some of these stumps that night herons have been making their nests for the last 10-12 years. Nests consisted of, as usual, dry twigs placed in the form of a crude saucer-like platform, approximately 50 cm wide, supported in forks of the stumps 1 to 4 m above water.

During 1986 I had observed 42 nests, whereas in 1987 there were only 25 nests (no observations were made in 1988 and 1989). I am not sure whether the irregular and much lower rainfall of 1987 was the cause of reduction in the number of nests.

The nest building activity started in August. During October 1986, I had seen nestlings from 2-3 to 10-15 days old. Some chicks had started climbing up the dry branches of the stumps, while others had started jumping on the nest and testing their wings. However, a few nests still had 1-3 blue-green eggs. I also saw four chicks in a nest. By the end of November, most of the fledgelings were flying about and very few adults were seen.

In general there were one or two nests on each stump, but a few had even four. Some stumps had no nests on them though they had forked branches. Distance between two adjoining stumps having nests varied from 10 to 50 m. The closest nest from the bank was at least 75 m away. All the nests were clearly visible to a bird of prey flying in that area. I had seen a pair of the Indian great horned owl *Bubo bubo*, a Bonelli's eagle *Hieraaetus fasciatus*, an osprey *Pandion haliaetus and a couple of pariah kites Milvus migrans* in the area, but did not see a bird of prey attacking any nest.

February 20, 1990 R.G. SONI

6. OBSERVATIONS ON A BREEDING COLONY OF PAINTED STORK *MYCTERIA LEUCOCEPHALA* (PENNANT) IN ANANTAPUR DISTRICT, ANDHRA PRADESH

Japanese Encephalities (JE) virus activity was reported in Karnataka as early as 1951 (Kerr and Gatne 1954, Smithburn *et al.* 1954). During a widespread epidemic in 1955, which covered parts of Andhra Pradesh, Tamil Nadu, Pondicherry and Karnataka, two cases of JE were recorded from Kolar district. In 1958, four cases of encephalitis occurred at Chintamani in the same district. A major outbreak was again reported in 1977, followed by frequent outbreaks of varying intensity in Kolar and Mandya district (Bhat 1984, Prasad *et al.* 1982, George *et al.* 1987).

Wading birds (Ciconiformes) play a role in the maintenance-transmission cycle of JE virus in nature (Rodrigues *et al.* 1981). A study to collect baseline information on the incidence and breeding activity of these birds was therefore commenced during 1980 as a part of the general investigations on the ecology of the virus. The main objective of the study was to correlate the migratory and breeding activity of the birds with epidemic outbreaks of the disease.

As a consequence of preliminary enquiry we received information from Dr. E.V. Shankarappa of Anantapur, Andhra Pradesh, in December 1982, that a large colony of a species of waders bred regularly every year at Veerapura village, Hindpur taluka, Anantapur district, 12 km from Bagepalli on the border of Kolar district. The village was visited on 15 May 1983.

We found a couple of hundred empty nests

distributed on half a dozen trees within the village limits. The villagers informed us that the birds nested and bred during the dry months of 1982, from January to June and departed, and they did not come back during 1983, perhaps because the tanks had dried up due to drought. The species breeding in the village was identified by the villagers as the painted stork *Mycteria leucocephala*, from pictures of various birds that we showed them.

The village was again visited on 6 March 1984, 4 July 1986 and 2 February 1987 and it was learnt that the birds did not resume breeding. The villagers told us that the birds arrived in small numbers during January, lingered on for a few days, foraged in nearby tanks which were almost empty and departed. On 2 February 1987 we ourselves observed 35-40 birds in nearby Venkatapura tank.

After a five year gap, the painted storks resumed their breeding activity at Veerapura in 1988. According to the villagers, the birds arrived during the last week of January and started building nests. The colony was visited by us on 9 February, 1 and 25 March, 14 April, 6 May and 10 June Nest building activity and incubation of eggs by some birds was observed on 9 February, 1 and 25 March and 14 April. Hatchlings were noted on 25 March and 14 April; fledgelings on 25 March, 14 April, 6 May and 10 June; and juvenile birds on 14 April, 6 May and 10 June. There were 155 nests on nine trees. The majority had two fledgelings each and a few had one or three fledgelings each. The total number of birds present in the mid-breeding season was estimated at 620.

Amidst the nest of painted storks, grey herons *Ardea cinerea* built two nests on one of the trees. The birds were incubating their eggs on 9 February. One of the nests had hatchlings on 1 March. Both of them had fledgelings on 25 March and juveniles on 25 March and 14 April. In two nests there were only three nestlings.

Painted storks returned for breeding in 1989. We visited the village on 2 February, 2 March, 10 March, 6 April, 19 May and 5 July. The villagers informed us that the birds emigrated during June/July 1988 and returned for breeding during the second week of January. On 2 February, they had already constructed 156 nests and laid eggs in 114 nests. On 2 March there were 307 nests, 100 under construction, 200 under incubation and 7 with fledgelings. On 10 March the number of nests had increased to 334, 100 of them had fledgelings, 10 had juveniles and rest under incubation. On 19 May the number of nests remained the same, 200 nests had young ones, 100 were empty and the remaining had fledgelings. On 5 July, 274 nests were empty and the remaining had juvenile birds still waiting for the food. There were in all 150 juveniles in and around the nests and 10 adults when visited.

The 334 nests built by the birds were distributed on 10 trees within the village boundary and the periphery. The species of trees and the number of nests on each tree are shown in Table 1. During the peak breeding activity the majority of nests had two fledgelings and a few had one or three. The total number of birds including young ones was estimated to be 1336.

TABLE 1

DETAILS OF PAINTED STORK NESTS AT VEERAPURA DURING 1989

Tree species	No. of nests
1. *Ficus religiosa* Linn. (pipal)	87
2. *Ficus religiosa*	26
3. *Tamarindus indicus* Linn. (tamarind)	21
4. *Ficus religiosa*	50
5. *Ficus religiosa*	76
6. *Prosopis chilensis* DC	12
7. *Ficus religiosa*	5
8. *Ficus religiosa*	34
9. *Tamarindus indicus*	22
10. *Tamarindus indicus*	1
Total	334

The villagers stated that the birds had been breeding in the village continuously for about 30 years until 1982. During 1982, there was a disturbance due to heavy lopping of trees, poaching of eggs and predation of eggs by monkeys. Perhaps the disturbance had scared the birds away and prevented the breeding during the intervening period from 1983 to 1987.

Some of the older villagers reported that before commencing to breed at Veerapura, more than three decades ago, the birds were breeding at Venkatapura village, about a kilometre away from Veerapura, from times immemorial.

Both during 1988 and 1989, at the end of the breeding seasons the nearby irrigation tanks were empty and the birds were flying away several kilometres for foraging.

Painted storks are known to have a strong fidelity to their breeding sites. In almost all the places the birds consistently arrive more or less at a particular time of the year, year after year, reconstruct the old nests or build new nests, lay the eggs, incubate them, rear the

young and emigrate to the foraging areas. However, the breeding seasons vary from place to place. Hume (1890) stated that the bird breeds immediately at the close of the monsoon, in October in upper India, and February in parts of southern India. Baker (1929) stated that the species breeds from September to January in large colonies and nearly always in company with numerous other storks, herons and cormorants, etc. Baker and Inglis (1930), quoting Hume, stated that these birds breed in February in parts of southern India. Ali (1953), Kahl (1970) and Breeden (1982) observed the breeding of these birds during August/September, July/August and June/July respectively at Keoladeo Ghana Sanctuary, Bharatpur, Rajasthan.

Ali and Ripley (1987) stated that the breeding species depended upon the monsoon conditions — August to October in north India, November to March in the south and March to April in Sri Lanka. However, recent observations at different places in peninsular India showed a lot of variation in the periodicity of breeding, often independent of monsoon conditions.

The breeding at Kokkare Bellur, Mandya district, Karnataka (Neginhal 1977, Saxena 1980, Nagulu and Ramana Rao 1983), and at Edurupattu, Andhra Pradesh (Nagulu and Ramana Rao 1983) commences during the dry seasons in January/February. But at Telineerapuram, Srikakulam district, Andhra Pradesh; Kundakulam and Moondraidappu, Tirunelveli district, Tamil Nadu, the breeding commences during October/November (Suresh Kumar 1980, Nagulu and Ramana Rao 1983), just at the commencement of north-east monsoon. Obviously the breeding season in northern India, coastal Andhra Pradesh and Tamil Nadu coincides with the monsoon season. However, at Kokkare Bellur, Edurupattu and Veerapura, the breeding occurs during the dry months of the year.

H.R. BHAT
P. GEORGE JACOB
A.V. JAMGAONKAR

January 9, 1990

REFERENCES

ALI, S. (1953): The Keoladeo Ghana of Bharatpur (Rajasthan). *J. Bombay nat. Hist. Soc. 51:* 453-461.

ALI, S. & RIPLEY, S.D. (1987): Handbook of the birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan and Sri Lanka. Compact second Edition. Oxford University Press, Delhi.

BAKER, H.R. & INGLIS, C.M. (1930): The birds of southern India including Madras, Malabar, Travancore, Cochin, Coorg and Mysore. Superintendent, Govt. Press, Madras.

BAKER, S. (1929): The fauna of British India including Ceylon and Burma. Birds, Vol. VI, Second Edition. Taylor and Francis, London.

BHAT, H.R. (1984): Public Health and environment. *In:* Karnataka state of environment report 1983-1984. Ed. C.J. Saldanha. Centre for taxonomic studies. pp. 132-137.

BREEDEN, S. & BREEDEN, B. (1982): The drought of 1979-1980 at the Keoladeo Ghana Sanctuary, Bharatpur, Rajasthan. *J. Bombay nat. Hist. Soc. 79:* 1-37.

GEORGE, S., GEORGE JACOB, P. & RAO, J.A. (1987): Isolation of Japanese encephalitis and West Nile viruses from mosquitoes collected in Kolar district of Karnataka state, during 1977-79. *Indian J. Med. Res. 85:* 235-238.

KAHL, M.P. (1970): Observations on the breeding of storks in India and Ceylon. *J. Bombay nat. Hist. Soc. 67:* 453-461.

KERR, J.A. & GATNE, P.B. (1954): Reconnaissance of immunity to six viruses in South India. *Indian J. Med. Res. 42:* 319-332.

NAGULU, V. & RAMANA RAO, J.V. (1983): Survey of South Indian pelicanries. *J. Bombay nat. Hist. Soc. 80:* 141-143.

NEGINHAL, S.G. (1977): Discovery of a pelicanry in Karnataka, *J. Bombay nat. Hist. Soc. 74:* 169-170.

PRASAD, S.R., GEORGE, S. & GUPTA, N.P. (1982): Studies on the outbreak of Japanese encephalitis in Kolar district, Karnataka State in 1977-78. *Indian J. Med. Res. 75:* 1-6.

RODRIGUES, F.M., GUTTIKAR, S.N. & PINTO, B.D. (1981): Prevalence of antibodies to Japanese encephalitis and West Nile viruses among wild birds in the Krishna Godavari delta, Andhra Pradesh, India. *Trans. R. Soc. Trop. Med. Hyg. 75:* 258-262.

SAXENA, U.S. (1980): Kokkare Bellur Pelicanry. *Cheetal 21:* 20-24.

SMITHBURN, K.C., KERR, J.A. & GATNE, P.B. (1954): Neutralizing antibodies against certain viruses in the sera of residents of India. *J. Immunol. 44:* 25-31.

SURESH KUMAR, V.K. (1980): Kondakulam Heronry. *Hornbill (2):* 10-16.

7. SNOW GOOSE *ANSER CAERULESCENS* — AN ADDITION TO THE INDIAN AVIFAUNA

The only reference to the snow goose *Anser caerulescens* in Indian literature is that of a white goose shot in Kashmir in February 1950 (Editors 1950). However, on later examination the specimen was found to be a partial albino of a greylag goose *Anser anser*, thereby expunging the snow goose from the Indian list (Abdulali 1966, Ali and Ripley 1983). This paper presents observations made on a single snow goose, observed twice and photographed in early January 1989 at a reservoir in Gujarat.

OBSERVATIONS

In January 1989, a team from the Department of Biosciences, Saurashtra University, and the World Wide Fund for Nature – India, Saurashtra Division, Rajkot, carried out surveys of waterbodies in the Saurashtra region of Gujarat as part of the third Asian Midwinter Waterfowl Count, the complete results of which will appear elsewhere.

On 9 January at 0940 hrs we reached Muli reservoir (22°39'N, 71°30'E), which is also known as Naika-I or Wadhwan Bhogawo-I and is situated north-east of the town of Muli (Surendranagar district). From the dam wall in the east, we observed a flock of geese on a mud bank on the north-west side of the reservoir. The flock consisted of 23 barheaded geese *Anser indicus* and one very conspicuously white goose. We were too far away to see the bird clearly and so we skirted about the reservoir to get a better view.

The land bordering the water here was cultivated with cotton *Gossypium* sp. and tall stands of *Eucalyptus globulus*. There was a small pond bordering the main reservoir with just a wall separating them. Along the wall was a thick growth of mesquite *Prosopis chilensis* that was being cut down by villagers. A goat herd tended his flock that fed close to the water's edge. Just beyond the wall and continuous with it was a gently sloping mud bank with geese at the farther edge. Some of the birds rested on the grass growing on the bank. Others fed on vegetation that had emerged with the fall in water level. The white goose consorted with the group and fed. They were not disturbed by our presence, nor by the goat herd, his goats and the woodcutters.

Using a telescope, we were able to observe the finer points of this white goose very clearly. It stood slightly taller than the barheadeds. It was entirely white except for the ends of the wings which at rest formed a black wedge above a white tail. The head was stained a dull yellow in the region of the forehead and ahead of the eyes and ear coverts. The feathers on both sides of the neck formed parallel creases slanting upwards towards the nape. The bill and legs were two shades of pink, in clear contrast to the yellow bill and legs of the barheaded.

The geese lifted off together and flew to a neighbouring mud bank when approached closer. This provided us an excellent opportunity to observe them in flight. The white goose had black primaries, light grey primary wing coverts and these contrasted well with the rest of the white wing feathers. The barheads in comparison were a light grey with dark grey black retrices and remiges. From all these field characters, it was clear that the white goose was an adult snow goose *Anser caerulescens*.

Two days later we visited the reservoir again to document the bird on film. The gaggle was at the same spot and the birds permitted close approach. A flock of demoiselle crane *Anthropoides virgo*, a pair of Indian black ibis *Pseudibis papillosa* and a small group of ruddy shelduck *Tadorna ferruginea* also rested with the group. The geese were photographed satisfactorily.

DISCUSSION

The reservoirs of Surendranagar district of Gujarat are now well known wintering sites for migratory geese. Raol (1988) first recorded a flock of barheads at Muli on 14 January 1984. Since then, barheads, and/or greylag goose *Anser anser* have been observed here every winter and some of the observations have been summarised by Van der Ven (1987) and Daniel (1988). But this is the first time that we have observed the snow goose.

The only previous reference of the snow goose in India is of a white goose shot from a flock of nine greylags by George Nedou on 26 February 1950 (Editors 1950). On later examination of the bird by Humayun Abdulali and S.D. Ripley, it was found to have been wrongly identified, and was in fact a partial albino greylag (Abdulali 1966). One of us (T.M.) has examined this specimen in the collection of the BNHS. The primaries are a shade of dull brown and quite unlike the jet black in the goose we saw. Colour transparencies of our observations clearly show the black primaries and other important identification features of the species.

To the best of our knowledge there are no snow geese maintained in captivity in India and so the possibility of this bird being an escapee from collections within the country is remote. We therefore conclude that the snow goose should be once again added to the list of Indian avifauna.

The breeding range of the snow goose extends from north-east Siberia, west to north-west Greenland and across arctic North America (Cramp and Simmons; 1977). The wintering grounds in Asia are in east China and Japan. In Europe it is considered an annual vagrant, but due to escapees from waterfowl collections there, the status there remains impossible to determine. The bulk of the arctic population however winters in North America and mainly around the Gulf of Mexico.

The snow goose should at present be strictly considered as a vagrant here. One possible explanation for its presence in India may be that the bird travelled down with the cold front that caused a severe winter over much of north and central Asia during December 1988 and January 1989.

ACKNOWLEDGEMENTS

One of us (T.M.) is grateful to the University Grants Commission, New Delhi, for a research fellowship during the course of which these surveys were made. We are thankful to Mr. Chandrakant Aghara for accompanying us and taking pictures of the goose. Prof. R.M. Naik kindly commented on an earlier draft of this manuscript.

TAEJ MUNDKUR
PRADEEP PANDYA
NARENDRASINH JHALA
RISHAD PRAVEZ
October 16, 1989 SHIVRAJKUMAR KHACHAR

REFERENCES

ABDULALI, H. (1966): Notes on Indian birds 9 — *Anser caerulescens caerulescens* (Linn.) and *Anser fabalis brachyrhynchus* Baillon to be removed from the Indian avifauna. *J. Bombay nat. Hist. Soc. 63:* 198-200.

ALI, S. & RIPLEY, S.D. (1983): Handbook of the Birds of India and Pakistan. Compact edition. Oxford University Press, Delhi.

CRAMP, S. & SIMMONS, K.E.L. (1977): Handbook of the Birds of Europe, the Middle East and North Africa. New York.

DANIEL, J.C. (1988): *Wetlands and Waterfowl Newsletter 1* : A 17.

EDITORS (1950): The Snow Goose (*Anser hyperboreus* Pallas) in Kashmir — An addition to the avifauna of India. *J. Bombay nat. Hist. Soc. 49:* 311-312.

RAOL, L.M. (1988): Barheaded and Greylag Geese in Gujarat. *J. Bombay nat. Hist. Soc. 85:* 416-417.

VAN DER VEN, J. (1987): Asian Waterfowl 1987. International Waterfowl Research Bureau, Slimbridge.

8. SHIKRA *ACCIPITER BADIUS* TAKING CARRION

A blue rock pigeon *Columba livia* was found dead on 6 June 1988, at 0600 hrs on the lawn of Darbargadh palace at Jasdan in Saurashtra, Gujarat. It had been killed by the palace dogs the previous night. House crows *Corvus splendens* fed on the corpse during the morning and at 1400 hrs a shikra *Accipiter badius* was observed feeding on it. Disturbed by our presence it flew with the carcass to a tree in the compound. Raptors are opportunists and species of the genus *Aquila* and *Haliaeetus* are known to feed frequently on carrion when opportunity avails (Ali and Ripley 1978, Brown and Amadon 1968, Brown *et. al.* 1982, Cramp and Simmons 1983, Clark and Wheeler 1987, Gensbol 1987). This appears to be an uncommon feeding behaviour among *Accipiters.* Ali and Ripley (1978), Brown and Amadon (1968), Brown *et. al.* (1982), and Cramp and Simmons (1983) make no mention of this habit though Newton (1986) states that the only evidence that the closely related sparrowhawk *Accipiter nisus* take carrion (apart from their previous kills) was the fact that they were occasionally poisoned when they took meat baits put out by gamekeepers. A photograph by B.E. Swann (in Gensbol 1987) shows a goshawk *Accipiter gentilis* and white-tailed eagle *Haliaeetus albicilla* at laid out carrion in winter.

Apparently *Accipiters* do take carrion in times of stress but this is the first record of a shikra doing so. Incidentally Saurashtra at this time was reeling under the third consecutive year of drought, but the two pairs of shikra I observed successfully reared young. The shikra was a daily visitor to the compound. Probably the same individual was earlier observed taking a displaying adult magpie-robin *Copsychus saularis* vulnerably exposed near its nest box.

November 22, 1989 RISHAD NAOROJI

REFERENCES

ALI, S. & RIPLEY, S.D. (1978): Handbook of the Birds of India and Pakistan. Oxford University Press, Delhi.

BROWN, L.H. & AMADON, D. (1968): Eagles, Hawks & Falcons of the World. Hamlyn Feltham, Middlesex.

BROWN, L.H., URBAN, E.K. & NEWMAN, K. (1982): The Birds of Africa, Vol. I. Academic Press Inc., London.

CLARK, W.S. & WHEELER, B.K. (1987): A Field Guide to Hawks of North America. Houghton Mifflin Company, Boston.

CRAMP, S. & SIMMONS, K.E.L. (1983): Handbook of the Birds of Europe, the Middle East and North Africa, Vol. 2. Oxford University Press, Oxford.

GENSBOL, B., (1987): Collins Guide to the Birds of Prey of Britain and Europe. William Collins Sons & Co. Ltd., London.

NEWTON, I., (1986): The Sparrowhawk. T. & A.D. Poyser Ltd., Calton.

9. CALLS OF HARRIERS (*CIRCUS* SPP.) NEAR HYDERABAD, ANDHRA PRADESH

We have been monitoring the roosting behaviour of three species of harriers — marsh harrier *Circus aeruginosus*, Montagu's harrier *C. pygargus* and pale harrier *C. macrourus* which come to roost on the ground in a grassland 18 km north of Hyderabad.

Before roosting the harriers show a pre-roost behaviour by flying over their roost site just before or after sunset. It was during this time that we heard some of the birds making a distinct shrill call. There is, however, no record of any such call for these birds in their wintering grounds (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983). But in all our four years (1985-89) of watching them, we have recorded them calling.

We heard the birds calling about 300 m from us. Twice a male Montagu's harrier came close to us. Its call, roughly *keck-keck-keck*, lasted a few seconds. Male pale harriers also gave a similar but a more shrill call. Marsh harriers have, however, remained silent.

The calls were heard throughout their wintering period (September to February), but were seen to be dependent on the number of birds during the pre-roost. If only a few birds came to roost then no call was heard. We also never heard any call at any other time of the day.

The exact purpose of such calls remains a mystery, but perhaps it has something to do with identifying its own species in the mixed pre-roost gathering. It is also not clear whether only males of the above two species call, since in the pre-roost gathering it is impossible to distinguish from a distance the species and sex which are calling.

T. GANESH
December 2, 1989 P. KANNAIAH

10. BLUEBREASTED BANDED RAIL *RALLUS STRIATUS* LINN. NESTING IN KERALA

According to the BIRDS OF KERALA (Ali, S. 1969) the nesting of the bluebreasted banded rail *Rallus striatus* had not been recorded from Kerala. According to the Report of the Vernay Survey of the Eastern Ghats (1936, *JBNHS 38:* 690) J. Darling found a nest with five eggs in a swamp at Sultan's Battery, Wynaad, on 26 August 1874. There seems to be no later report of the breeding of this rail in Kerala. We place on record the discovery of a nest of this bird at Kavassery (Palghat district, Kerala, *c.* 90 m above msl).

On 28 July 1989 Achuthankutty Nair, while walking along a bund in his paddy fields in the evening, saw a waterhen-like bird flying out of a dense growth of grass and lentils almost at his feet. This led to his discovery of a nest containing 5 eggs. He showed me the nest the next morning. After that, we frequently visited the nest and spent about an hour every time in the hope of seeing the occupants of the nest. At 0930 hrs on 30 July 1989 there were seven eggs in the nest; at 0900 hrs on 1 August 1989, it contained eight eggs; and at 1700 hrs on 2 August, nine eggs. No more eggs were laid. On our visit on 10 August 1989, the bird was so agitated that we decided to leave the nest alone for some days. On our next visit at 1745 hrs on 15 August 1989, we found that all the eggs had hatched. Nine egg-shells, each with a large hole on one side, were in the nest. We could not find the chicks or the parents anywhere in the vicinity.

Occupants of the nest: Eight times — on 28 July, 30 July, 1 August (once in the morning and again in the evening), 2 August, 6 August and 10 August — a bird was flushed from the nest. But on most occasions, apart from noting that it was a rail smaller than a whitebreasted waterhen Amaurornis phoenicurus, we could not get any details as the bird just fluttered into

the dense paddy beside the bund. On some occasions Nair was able to note some details.

Piecing these together, we decided that the bird's head and the back of its neck were reddish, the breast bluish-grey, the back and wings brown with numerous thin white transverse bars, the eyes red, and the legs greenish-grey. On 3 August, I saw a rail crossing a bare bund (a foot-path) from one field to another. I was able to note that the bird's chin was white, the foreneck and breast bluish-grey, the crown, nape and hindneck reddish; and also that the brown back and the wings were full of narrow white bars lying across the body. I could not catch the colour of the eyes or the legs, and I had no time to use the binoculars. On 10 August when I got a glimpse of the bird sitting on the eggs, I saw that a good part of its beak was bright red. From all this I was able to identify the bird as a bluebreasted banded rail *Rallus striatus*.

The nest: The bund on which the nest had been built was mostly overgrown with grass, lentils and other plants. Beside the bund was a small pool in which some people used to bathe and wash clothes every morning. The birds had chosen a particularly dense patch of grass over and around which ran lentil creepers. A deep saucer (16 cm across and 19 cm deep when measured on 15 August) had been made in the damp soil and some of the grass along the rim pulled down, twisted round and pressed to the sides of the depression to form a lining. Some blades of paddy were also found incorporated into the lining.

When I first saw the nest, the grass on one side had been so manipulated that there was a short, neat tunnel leading to the nest. But whenever we approached the nest from the side on which the entrance was, the bird slipped out through the back. We had reason to suspect that, at least once, the eggs had been shifted deeper into the herbage. Except on the side where the pool was, tall paddy grew close to the bund, making it easy for the sitting bird to slip away into the paddy.

Behaviour during incubation: It could not be ascertained whether both the parents, or only the female, incubated. The bird in the nest was a close sitter and would leave the nest only when we moved the herbage. It would then fly some 3 m or less and drop into the paddy. On 5 August Nair went to the nest a few minutes after a woman had walked past the nest (less than 30 cm away) and he was surprised to find the bird still sitting on the eggs. When he bent down for a closer look, the bird shuffled one wing at a time and then pulled its wings close to the body, but did not leave the nest. On 6 August when another bird-watcher, Shyam Prasad Anand, and I went to look at the nest, the bird refused to budge until we had begun moving the grass. It then quietly walked down the slope of the bund into the paddy.

On 10 August the bird refused to leave the nest although Nair and I stood near it for quite some time, talking, and even moved some of the herbage aside. It just pressed itself down into the nest, turning its head to one side to look at us! That, luckily, gave me a chance to see the bright vermilion colour of part of its bill. It was only when Nair pushed aside the grass close to the bird's body that it got up, ran through the vegetation and fluttered into the paddy about a metre from the bund. Instead of hiding as it used to do, on this occasion the bird seemed to run in circles through the paddy, deliberately causing it to rustle. Moreover, for a moment the bird came to the foot of the bund, its wings half-open and trailing, as though it hoped to entice us away from the nest. This unusual behaviour could have been a sort of distraction display prompted by the fact that the eggs were at an advanced stage of incubation.

Call-notes: The incubating bird never uttered any sounds even when flushed. But another (probably its mate) used to call for some time in a field some 20 m away from 1730 hrs. It would start with five or six single *trrrik*s and then run the notes together into a sort of song. After that it would again utter some disjunct *trrrik*s and either fall silent or start another run of *trrrik*s. The *trrrik* note had a distinct metallic quality. I was able to record some of these calls on tape, and from these discovered that the longest of the runs lasted 30 seconds. On a single occasion two birds were heard calling from adjacent fields.

I never heard a call resembling any of those quoted from Hume and Baker in the HANDBOOK, or the "noisy *ka-ka- ka*" quoted from Timmis in RAILS OF THE WORLD (Ripley, S.D.) What I heard was close to the "sharp *terrik*" quoted from Delacour in *Rails of the* WORLD. This, by the way, is the only call-note described in BIRDS OF KERALA. However, there is no reference in any of these books to the running together of the *trrrik*s into a song.

The voice of this rail is not heard as often as those of the kora (waterhen) Gallicrex cinerea or the whitebreasted waterhen, nor is it half as loud as the other two. Moreover, this rail seems to vocalise only for a very short period during its breeding season.

Eggs: The texture, colour and markings of the eggs were as described in the HANDBOOK. On 15 August I

brought home four of the nine shells and measured them as precisely as I could using a scale and graph-paper. One egg measured 34 x 25 mm, the others 33 x 25 mm.

Incubation period: The bird was first flushed from the nest when there were only 5 eggs in it, and again when there were 6 eggs and 8 eggs. This suggests that incubation commences long before the clutch is completed. However, since the ninth egg could have been laid only on the first or the second of August, and it hatched along with the others some time between the 10th and the 15th, that egg could not have undergone incubation for more than 14 days. The HANDBOOK gives the incubation period as 18-22 days.

I am deeply indebted to Achuthankutty Nair for informing me of the nest as well as for his active interest in and assistance at every stage of this short study.

August 18, 1989 K.K. NEELAKANTAN

11. BREEDING OF THE KORA OR WATERCOCK *GALLICREX CINEREA* IN KERALA

When, after an absence of nearly 40 years, I returned in January 1986 to reside permanently in my native village of Kavassery (Palghat district, Kerala) one of my neighbours, a farmer who used to shoot birds for the pot, told me that a large black bird with a pointed red comb and loud booming calls had become a regular monsoon visitor to this area since about 1960. Realising that he was referring to the kora *Gallicrex cinerea*, I requested him and various other farmers of the village to let me know if they came across a nest of this bird.

With the arrival of the south-west monsoon in June 1986 the kora returned to this locality and made its presence felt by calling regularly every morning, evening and night. Male koras could be seen easily at various places till the paddy grew tall enough to hide them. Three monsoons went by without providing me with any evidence of the kora's nesting in this region. As I had explained in an earlier note (*JBNHS 87:* 293) on the voice of the kora, I began to suspect that most of the koras that visited this area were males that had not begun to breed.

This conjecture was disproved on 14 September 1989, when I was brought a juvenile kora which had been captured by reapers from a paddy field. It had been found with another chick in the company of a male kora. The other chick had died of injuries inflicted by a reaper's sickle, and the male had flown off.

The chick that was brought to me was about the size of a waterhen *Amaurornis phoenicurus*. It was fully feathered but had no rectrices. Only some rough measurements could be taken. They were: bill (straight from the tip to the top of the frontal shield) - 3 cm; tarsus - 7 cm; middle toe without the claw - 7 cm; hind toe without the claw - 2.5 cm. As the remiges had not grown fully, the wings were not measured.

In shape and general appearance the chick resembled the illustration of a female kora by G.M. Henry in his GUIDE TO THE BIRDS OF CEYLON (1955 edition, p. 352) very closely but for the legs, which are unnaturally stout in the picture. The head and the back of the neck were brown; the chin and throat whitish; a broad stripe over the eye, and the cheek, were pale buff; there was a curved brown streak below the eye. The neck, breast, flanks and thigh-coverts were pale fulvous. The neck and breast were cross-barred with fine wavy black lines and the flanks, sides of the abdomen and thigh-coverts cross-barred with thicker and darker lines. The abdomen was unbarred and was paler buff than the breast and flanks. The feathers of the wing-coverts and scapulars were all dark brown with broad fulvous fringes. The remiges were dull blackish-brown; the edge of the wing and the narrow outer web of the outermost primary were pure white. The frontal shield, the culmen and the tip of the bill were horny (dull brownish-black). The rest of the bill was at first pale ochre but later turned yellowish-pink. The eyes were dark brown.

The food the chick fancied most was small freshwater fish. If offered fish larger than 50 mm long, it used to eat the front half fully and leave the rest more or less untouched. Small aquatic snails were also readily consumed. Paddy and fresh cucumber seeds were eaten if fish was not available, but the seed-heads and tender shoots of wild grasses were ignored.

24 hours after it had been put in a cage the chick slipped out through the bars (which were 2.5 cm apart), jumped to the ground and ran very fast. It never attempted to fly even when chased by a number of boys. After its recapture, the sides of the cage were covered with chickenwire mesh.

The chick never uttered any sounds even when, on 15 September, it was chased and caught. But eight days later, when taken out of the cage for a closer inspection and measurement, it uttered a series of loud, harsh and

nasal *krey*'s. It gave vent to similar calls when taken out to be released on 9 October. But although it was still being held by the legs, during the 15 minutes it took us to reach the spot chosen for its release (a small pool surrounded by dense bushes and paddy fields) the chick remained quite silent.

During the day it often rested standing on one leg or squatting with its legs folded under it. On the only occasion when I managed to catch it fast asleep, it had turned its head back and thrust its beak into the feathers of its back. Generally, when its cage was approached, it would turn towards the person and, after raising its head and fully extending its neck, would lower its head with a smooth third motion almost to its toes and straightaway raise it again. After repeating this a number of times it would suddenly leap up in vain attempts to get out of the cage. It was first noticed flicking its hind end (no tail feathers had appeared even on the day of its release) on 29 September. Thereafter it did so quite frequently.

In his BIRDS OF KERALA (1969) Salim Ali says that the nesting of the kora had not been recorded from Kerala. To the best of my knowledge the present report is the first record of the bird's breeding in south India.

October 26, 1989 K.K. NEELAKANTAN

12. HITHERTO UNRECORDED NESTING SITE OF YELLOW-WATTLED LAPWING *VANELLUS MALABARICUS* (BODDAERT)

On 1 May 1988 we came across a yellow-wattled lapwing *Vanellus malabaricus* sitting amidst thick green grass *c.* 15 cm high. The bird slunk away when we approached it. To our great surprise we saw two eggs there without any sign of a nest. We retreated from the spot immediately and the lapwing returned to the nest and resumed incubation. The bird was incubating the eggs when we visited the spot at 1000 hrs the next day. But the eggs could not be seen there at 1700 hrs the same day. A solitary yellow-wattled lapwing was preceding at some distance.

The typical nest is "an unlined shallow scrape on dry open sunbaked fallow or waste land" (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1969). All nests we observed in the Calicut University campus since 1980 were lined with pebbles, cowdung and small pieces of dry grass. But here not even a scrape was seen; the eggs were laid simply amidst grass.

The situation in which the nest was found deviates from recorded nest sites and we wonder at the survival value the bird had in departing from the normal.

K. VIJAYAGOPAL
November 21, 1989 STEPHEN CHACKO

13. GREENSHANK *TRINGA NEBULARIA* (GUNNER) FEEDING ON LARGE FISH

One aspect of the BNHS studies in the Great Vedaranyam Swamp in Thanjavur district of Tamil Nadu under the project 'Ecology of Point Calimere Sanctuary (An Endangered Ecosystem)' looks into the impact of an industrial salt works on waterbirds.

The birds that generally frequent the pumping station that pumps sea water into the main reservoir are fish-eating birds like egrets, storks, gulls and terns. These birds prey on the schools of fish swimming against the current of the pumped-in water. During census in the first week of September, I was surprised to see a flock of 18 greenshanks *Tringa nebularia* feeding on fish up to 5 cm long. Each bird would catch fish from the water's edge, take it to the shore, peck and handle it for about a minute before swallowing it head first. Swallowing was difficult, the bulge of the fish being conspicuous in the throat while swallowing.

Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Compact Edition, 1983) do not list fish as part of the diet of greenshank. Incidentally, Ali and Ripley had reported a frog in the crop of a specimen, "seemingly too big for the narrow bill and gullet". However, Cramp and Simmons (HANDBOOK OF THE BIRDS OF EUROPE, THE MIDDLE EAST AND NORTH AFRICA 1985) mention that the greenshank feeds on fish fry regularly. However, in this cited case, the size of the fish was large.

September is the end of the salt extracting season and once the north-east monsoon breaks, salt production stops for about four months. During this period, less water than normal is stored in the reservoirs and condensers. This results in higher salinities and temperatures in the salt complex, as a result of which

fish kills occur. On days when water is pumped in, weak fish swim towards the fresh sea water at the pumping station. Greenshanks utilise this opportunity and catch weak or dying fish.

September 19, 1989 RANJIT MANAKADAN

14. A FLOCK OF ONE-LEGGED GREENSHANKS *TRINGA NEBULARIA*

On 20 February 1989, I sighted a flock of 15 greenshanks *Tringa nebularia* in one of the condensers of the Mettur Chemical & Industrial Corporation near the Point Calimere Wildlife Sanctuary in Thanjavur district, Tamil Nadu. Of these 15 birds, nine had only one leg each. What could be the reason for the congregation of one-legged greenshanks?

The greenshank is usually solitary or in small parties of 3-5. However during migration they may form flocks of more than 15-20 (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Ali, S. and Ripley, S.D. 1983). I presume the flocking of one-legged birds was not incidental but forced grouping of handicapped birds together for migration back to their wintering grounds as they were not able to keep up with healthy birds.

September 19, 1989 RANJIT MANAKADAN

15. RIVER TERN *STERNA AURANTIA* GRAY SNATCHING A FISH FROM PARIAH KITE *MILVUS MIGRANS* (BODDAERT) IN FLIGHT

On 3 November 1989, I visited Tighra dam in Gwalior district of Madhya Pradesh in connection with my month-wise survey of birds. I saw a pariah kite *Milvus migrans* flying over the water with a fish in its claws, coming towards me from across the dam. I had no way of knowing whether the kite had actually caught a live fish, or had just picked up a dead one.

A river tern *Sterna aurantia* that was trying to catch prey in the water, suddenly attacked the kite and tried to 'snatch' the fish from its claws. The tern repeatedly attacked the claws of the kite with its bill. The kite tried to defend itself by turning, twisting and increasing speed. But after some efforts the tern succeeded in snatching the fish. While snatching the fish, the tern seemed to be stationary for a second or so. The tern devoured the fish before landing on the ground.

September 18, 1989 RAJIV SAXENA

16. RANGE EXTENSION OF ASHY WOOD PIGEON *COLUMBA PULCHRICOLLIS* BLYTH

A Himalayan forest bird, the ashy wood pigeon *Columba pulchricollis* occurs between *c.* 1200 and 3200 m from west-central Nepal through Sikkim, Bhutan, Arunachal Pradesh and probably Nagaland and Mizoram. Like other fruit pigeons it is subject to considerable wandering depending on fruit supply. It is recorded locally in the Bengal duars and Arunachal foothills as low as 100-150 m (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Compact edition, Ali, S. and Ripley, S.D. 1983). However, there is no record from the foothills in Assam.

One individual of this species was seen in Manas Wildlife Sanctuary on 3 May 1988. It was spotted on the road in a mixed, fairly dense forest (26°43'N, 91°E) of tropical semi-evergreen type, about halfway between Basbari and Mothanguri. The altitude of the sighting was less than 100 m (*c.* 80 m according to local forest department authorities). This is perhaps the first sight record of this pigeon from the foothills in Assam below Bhutan Himalayas, and that too at such a low elevation.

GOUTAM NARAYAN
August 30, 1989 LIMA ROSALIND

17. ABNORMAL NESTING BEHAVIOUR OF LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS CAMBAYENSIS* (GMELIN)

During the course of a short term project on 'Ecological Isolation among Doves', we recorded a pair of little brown dove *Streptopelia senegalensis* building quite a large nest in a room of a coal depot located in a busy area of Aligarh town. The dove laid four clutches in three months. It discarded three clutches but the fourth was successfully hatched. The breeding behaviour was unusual in various aspects, viz. nest site, clutch size and nesting materials. All these differed from the information given by Ali and Ripley (1973).

Methodology: Observations were carried out mainly in the afternoon. Measurement of nest and number of eggs were recorded. Observations were taken from a distance of three metres. Percentage of attentiveness was calculated by dividing the time spent by bird at nest by the total observation time.

Observations: The nest was spotted on 3 October 1986 and first laying was observed on 8 October. Two layings were observed on 15 and 27 October and the final laying on 20 December. The time between first and second layings was seven days; between second and third 12 days; and between third and fourth it was 53 days.

The first egg laid on 8 October was incubated for three days before being discarded. The second egg was incubated for eight days. The third clutch was of two eggs and the bird incubated it for 16 days, but the eggs were probably infertile. On 20 December two eggs were laid and successfully incubated. The young hatched on 2 January 1987, giving an incubation period of 14 days.

Nest attentiveness: The dove did not attend the first two clutches. In the third clutch maximum attentiveness was 24.1% in the beginning which decreased to 11.4% in the third observation. In the fourth clutch the attentiveness increased from 28% in the beginning to 76.6% at the end.

During the observations an interesting shift pattern was seen. The room had two ventilators (1 and 2); ventilator 1 was the normal entry point, but the second bird entered from ventilator 2 to relieve its partner. The incubating bird used to leave the nest only when it was assured of replacement by its partner. It always moved to ventilator 1 and sat there till the reliever occupied the nest. While incubating, the bird constantly changed the position of eggs to provide equal heat to all sides of the eggs. During the later part of the incubation period the bird was seen broadening the brood patch by plucking 4-5 feathers from the abdominal region.

Nest: The nest was built on an electric meter board inside a small room located in a coal depot. There was peepal tree *Ficus religiosa*, a neem tree *Melia azadirachta* and common grass (doob) *Cynodon dactylon* in the vicinity. The coal depot was in an area with factories all around.

The nest was at a height of 2 m from the ground. The base of the nest rested on the electric meter board. The nest measured 22.5 cm in length and 15 cm in width at the top, and was lined with thin copper wires available from the adjoining factories. The main nesting material was dry twigs of neem and dried grass.

The observations determine the incubation period of the little brown dove as 14 days, and indicate that like other birds on certain occasions this dove also can change its set pattern of nesting behaviour. The discarding of three earlier clutches could be on account of inexperience of the pair as has been recorded in the small green barbet *Megalaima viridis* by Yahya (1980).

SALIM JAVED
H.S.A. YAHYA

March 12, 1988

REFERENCES

ALI, S. & RIPLEY, S.D. (1983): Handbook of the Birds of India and Pakistan. Compact edition Vol. 3, p 155. Oxford University Press.

GEORGE, J. (1956): A Sunbird's unusual nesting site. *J. Bom. nat. Hist. Soc. 54 (4):* 943.

HUMAYUN, A. (1947): Peculiar behaviour of Darter. *J. Bom. nat. Hist. Soc. 47 (3):* 549.

KINGSLEY (1944): Peculiar behaviour of Bronze winged Jacana. *J. Bom. nat. Hist. Soc. 45 (3):* 238.

PARSON, R.E. (1947): Curious Nesting site of Magpie robin *J. Bom. nat. Hist. Soc. 47 (1):* 159.

WAIT, H.W. (1920): Curious Nesting Behaviour of Hoopoe J. *Bom. nat. Hist. Soc. 27 (1):* 171.

HACKNEY, M.S. (1951): Unusual Behaviour of White capped Redstart. *J. Bom. nat. Hist. Soc. 50 (3):* 655.

YAHYA, H.S.A. (1980): Ecology & Biology of Barbets. Ph.D. thesis, University of Bombay.

18. HOVERING: AN UNRECORDED BEHAVIOUR IN THE INDIAN CUCKOO *CUCULUS MICROPTERUS*

The Indian cuckoo *Cuculus micropterus* is one of the most commonly heard cuckoos of Assam. During a survey of the state in April 1988 they were found to be very vocal at Kaziranga National Park, Manas, Orang, Pabitora, Laokhowa, Barnadi and Sonai-Rupai Wildlife Sanctuaries.

An unusual foraging behaviour of the bird was seen near Manas on the morning of 14 May 1988. In a thatch field of Fatemabad tea-estate at Basbari (91° E, 26° 39' N) bordering the sanctuary, we noticed an adult Indian cuckoo descend from a tree to a shrub (*c.* 1 m high) growing among much shorter grass. It soon took off and began hovering against moderate wind at about 1.5 m above ground. Although it was a bit clumsy it could hover at one spot for 5 to 10 seconds. It slowly flapped the upraised wings and occasionally fanned out the tail for balance, sailing from one spot to another to hover, again taking advantage of the wind. Every now and then it descended to catch insects from short grass and returned to its low perch to feed. There was a considerable increase in insect population, specially of the grasshoppers, in the grassland after a few showers at that time. The black drongos *Dicrurus adsimilis* were seen competing with the cuckoo for insects.

Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) have mentioned that this chiefly arboreal cuckoo sometimes descends to the ground and hops about awkwardly to pick insects from among litter leaves. There is no mention of hovering by this or other cuckoos.

GOUTAM NARAYAN
LIMA ROSALIND

August 30, 1989

19. EARTHWORMS IN THE DIETARY OF THE WHITEBREASTED KINGFISHER *HALCYON SMYRNENSIS* (LINN.)

Following up A.K. Mukherjee's observation on the diet of the whitebreasted kingfisher *Halcyon symrnensis* in the Sunderbans (*JBNHS 72(2):* 418-22), an individual was observed on the Aligarh University Campus on 15 September 1989 in cloudy weather pouncing on an earthworm from its perch *c.* 8 m up. It picked up the earthworm and swallowed it squatting on the ground. On finishing, it flew up to an telegraph wire, and thence flew down again for a second earthworm and swallowed it. The bird dived for the third time and carried off to its perch a fattish looking earthworm again, and having battered it on the perch, swallowed it entire. Almost the same way, the same bird was found feeding on earthworms the next morning.

Although earthworms in the diet of the bird is not mentioned anywhere else in literature except by Mukherjee (loc. cit.) it appears that earthworm eating is not restricted to Sundarbans kingfishers alone.

H.S.A. YAHYA
SHAHLA YASMIN

September 30, 1989

20. DRINKING AND BATHING BEHAVIOUR OF THE LARGE GREEN *MEGALAIMA ZEYLANICA* (GMELIN) AND THE SMALL GREEN *M. VIRIDIS* (BODDAERT) BARBETS

While carrying out observations on the comparative ecology and biology of barbets (*Megalaima* spp.) I have, on various occasions, recorded them drinking and bathing. Though the other habits of barbets have been published earlier, as far as I am aware this behaviour is unrecorded.

Any open natural rain-filled tree hole serves as a drinking and bathing 'pool' for the birds. On no occasion were the birds seen landing on the ground for this purpose. In this sense they are completely arboreal. During the dry months no drinking and bathing was observed.

The bird perches at the edge of the hole and dips the beak into the water and raises it, repeating this process several times to quench its thirst. Drinking mostly lasts for 15 to 35 seconds. The duration of bathing depends on whether the bird is single or in a group: when single, as long as 11 minutes; and when in a group (normally consisting of 3-5 birds) mostly for 2-3 minutes. Since the 'pool' is always small, one bird

at a time is the norm.

The method of bathing is sequential. The bird perches near the edge of the pool and wets the anterior parts of its body with the beak, then turns about and splashes water into the plumage by flapping the wings and fanning the tail. This lasts about one minute and is followed by thorough preening for about the same period. During the preening the bird often flutters the wings rapidly and fluffs up the body plumage several times. This process is repeated several times, till the bird is either satisfied or disturbed by another bird. A thorough prolonged preening now follows, sometimes for 15 minutes. Exposed branches are preferred for this purpose and the bird often calls during the preening.

During rains the bird dries the plumage by preening, fluttering the wings, fluffing up the body, but was rarely found having a regular bath.

At times *M. viridis* was observed drinking and bathing with several other species of birds at the same pool, the fairy bluebird, goldfronted chloropsis, and jungle myna being the common associates. Inter and intraspecific chases were also recorded when *M. viridis* being the most aggressive, rarely tolerated other species.

December 15, 1989 H.S.A. YAHYA

21. COURTSHIP FEEDING IN THE INDIAN HOUSE CROW *CORVUS SPLENDENS* VIEILLOT

Courtship feeding occurs in many groups of birds during the breeding season. It involves offering of food by a partner to its mate.

While studying the nesting behaviour of the Indian house crow *Corvus splendens* in the Lower Gangetic plain, I noticed that the male offers food to the female just after mate selection. The female begs for food with wide gape, quivering of tail, spreading and trembling of wings in the attitude of a young bird. Courtship feeding continues through the entire period of incubation till a week after the hatching of nestlings. The male feeds the female on the average 10.3 times per hour (62 observations in 3 hours) through the entire period of incubation. With the hatching of nestlings, the sequence of such feeding comes down to an average of 5.6 times per hour, as the male now shares its responsibility of bringing food for the nestlings.

In view of the fact that courtship feeding in the house crow begins immediately after mate selection and continues through incubation till a week ater hatching of nestlings, it may be suggested that the behaviour in this case involves three distinct functions, namely:
(1) It begins as a token of final ritual of mate selection (Lack 1940), (2) Later it continues to maintain and strengthen the pair bond (Armstrong 1965), and (3) It also provides proper nourishment to the incubating female (Lack 1968).

January 16, 1990 SUDHIN SENGUPTA

References

ARMSTRONG, E.A. (1965): Bird display and behaviour. Dover, New York.

LACK, D. (1940): Courtship feeding in birds. *Ibis. 57:* 169-78.

LACK, D. (1968): Ecological adaptation for breeding in birds. Methune & Co.

22. OCCURENCE OF THE ASHY MINIVET *PERICROCOTUS DIVARICATUS* (RAFFLES) IN KERALA

The ashy minivet *Pericrocotus divaricatus* breeds in north-east China, Japan, Korea and the Soviet Far East, migrating in winter to Taiwan, the Phillipines and most of south-east Asia, including, rarely, Burma.

On 7 December 1989 I was watching a mixed hunting party in the fairly open moist-deciduous forest along the edge of the road close to the DFO's office at Thekkady in the Periyar Sanctuary, Kerala. Species present in the party were the yellowbrowed bulbul, ashy and racket-tailed drongos, velvetfronted nuthatch, whitebellied tree pie, grey tit, small green barbet, golden oriole and both small and scarlet minivets. The latter, at a height of about 8 m in the canopy of a small tree on the very edge of the forest, were joined by

another minivet, the plumage of which was white below, grey and dark grey above, and lacking any other colour at all. I had been joined a few minutes before by Joseph Karoor of the Forest Department, and we were both immediately aware of the difference of this new arrival. Binoculars had hardly been focused on it when the bird was harassed by one of the racket-tailed drongos and chased in two circuits around the spot where we stood until it disappeared. In spite of its rarity and the short time it was in view there was no doubt in either of our minds that it was indeed an ashy minivet *Pericrocotus divaricatus*. This is the first record of the species in Kerala, and the third for the Indian mainland, the earlier two being Navarro's (*JBNHS 62:* 303) and Santharam's (*JBNHS 85:* 430-31).

February 1, 1990 ANDREW ROBERTSON

23. BULBULS FEEDING ON THE PULP OF *CASSIA FISTULA* POD IN PT. CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

At Pt. Calimere Wildlife Sanctuary, two species of bulbuls, namely redvented bulbul *Pycnonotus cafer* and whitebrowed bulbul *Pycnonotus luteolus* occur. Vijayan (1975) studied the ecological isolation of these two species of bulbuls at Pt. Calimere and had recorded 36 species of fruits being eaten by them. He also recorded flowers, flower nectar and insects as their food. Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) mentioned fruits, flower nectar, insects and spiders as being the food of both bulbul species.

At Pt. Calimere Wildlife Sanctuary, during three years of study on frugivory by birds and mammals, it was noticed that both the bulbul species visit *Cassia fistula* L. (Caesalpiniaceae) trees to eat the pulp of the pods. *Cassia fistula* is a commonly occurring tree in Pt. Calimere and the pods are cylindric, measuring 45 to 75 cm in length, containing 70 to 120 seeds, one centimetre long, embedded in a sweet blackish pulp and separated by woody septa from each other. The ripe fruits are brown and the fruiting season is from May to August.

During the months of June and July both bulbul species visit this plant to feed on the pulp. The bird perches on the fruit, pecks the hard, thick fruit wall and after breaking it, eats the pulp. The pulp alone is swallowed, and the seeds are not eaten. Each feeding visit lasts for a few minutes and repeated visits are made.

Available literature records the two species feeding mostly on fleshy berries and drupes and usually ingesting the seed with the pulp. In one exceptional case, viz. *Rivea hypocrateriformis* recorded by Vijayan (Ph.D. thesis, University of Bombay, 1975), the fruit is a capsule and hence easily pecked and eaten. In the case of *Cassia fistula* the bird has to break open the hard fruit wall of the pod to eat the pulp. Hence, this feeding method and the food item (pulp of a pod) are new to the bulbul's feeding biology.

I am grateful to Prof. P.V. Bole, President, Bombay Natural History Society, for his guidance, Mr J.C. Daniel, Curator, BNHS, for encouragement and Dr V.S. Vijayan, Project Scientist, Ecological Research Station, Bharatpur, for his comments.

December 5, 1989 P. BALASUBRAMANIAN

24. YELLOWRUMPED FLYCATCHER *FICEDULA (MUSCICAPA) ZANTHOPYGIA (NARCISSANA):* A NEW ADDITION TO THE AVIFAUNA OF THE INDIAN SUBCONTINENT

On 30 April 1989 around 1530 hrs I, Sandeep Mehta, Mukund Thakker and Jayashree Sethna were bird-watching at Semadoh, along a streambed near the bus-stand in the Melghat Sanctuary (21.30°N, 77°E) in Maharashtra. There were magpie-robins *Copsychus saularis,* whitebrowed fantail flycatcher *Rhipidura aureola* and some species of warblers flitting around in the streambed. We went down to have a closer look at them and from near a rock pool, a small golden yellow and black bird flew away further downstream towards the bridge on our approach. Since it appeared interesting I cautiously followed. It was a flycatcher-like bird and I noted the following description.

Sparrow-sized, colours mainly black upperparts and yellow underparts. Upper parts: head, back, wings

and tail black, tail short and square; bill short, black and slightly hooked at the tip; white eyebrows, reaching slightly beyond the eyes. The eyebrows did not meet on the forehead but made a V-shaped black patch; very long white wing bar (3 to 4 cm) like that of the magpie robin; throat and breast bright golden yellow, fading towards the vent; rump yellow; legs black. It was sitting at an angle of 40-45° on a prominent rock near a rock pool. In the shaded patches near the water, under the rocks, were clusters of some species of Diptera. The bird would fly to these patches and disturb the insects to catch a few and return to the same rock. Its behaviour was that of a typical flycatcher.

I could not remember any such bird among our flycatchers and thought that it was perhaps a Himalayan flycatcher-warbler such as the greyfaced leaf warbler *Phylloscopus maculipennis* which has a yellow rump and belly and white eyebrows, but does not have the long white wingbar and yellow breast; similarly the greyheaded flycatcher warbler *Seicerus xanthoschitos* has some of the characters, but has olive green upper parts and a longer tail. We therefore concluded that this could not be any of the flycatcher-warblers. We watched it for about half an hour at different spots and tried unsuccessfully to identify it with the help of the PICTORIAL GUIDE (Ali, S. and Ripley, S.D. 1983). On the afternoon of 2 May I visited this area along with Dr R Godbole (Pune) and M Chitampalli (ACF Melghat). Only Dr Godbole got a glimpse of the bird.

Again that evening I and others went to see the bird. We found it in the same place. We watched it for about an hour or so and noted down its description, details of the habitat and its behaviour. I used 8 x 30 binoculars to watch the bird.

I could approach the bird as close as 4 m, but whenever I was with the camera it did not allow me to go closer. Still, I managed to take three photographs with a 200 mm telephoto lens from a distance of about 10 m, which show some of the typical characters.

The following two days, i.e. 3 and 4 May, we saw the bird at the same place. We were unable to locate it around 0700 hrs on the 5th, after which we had to return to Bombay.

On returning to Bombay Mehta and I went through the BNHS collection foı similar looking species, referred to the literature and consulted others, including S.A. Hussain, Project Scientist at the BNHS. Flint *et al.* (1984) depict a picture of the Narcissus flycatcher *Muscicapa narcissus* which resembled the bird we had seen. Five subspecies are mentioned by Dementiev and Gladkov (1968). The description of the duarian yellowbacked flycatcher *M. narcissus zanthopygia* fitted very well with our own description. The habitat and distributional range for the bird was given as:

"Range — Continental form breeds in Ussuri area to Gorin rivers, in the east Sikhote-Alin to 45°N latitude, in the west Amur to Kumara and Dzhatmda. In the south to Lake Tare, Argun river. Outside Soviet territory in Manchuria, Korea, north-east China with southernmost occurrence at Peking. Winters in Malayan Peninsula. Biotope: Chiefly river bottom lands with rich luxuriant vegetation, valleys of streams and dense undergrowth."

As it was a winter migrant to south-east Asia we referred to all the available books on the birds of south-east Asia; the colour plate in Meyer (1984) closely resembled the bird we had seen. On this basis we identified it as a male *Ficedula (Muscicapa) zanthopygia (narcissana),* which has many common names like yellowrumped flycatcher, Korean flycatcher, yellowbacked flycatcher etc.

We also compared our photographs with the three specimens (two males and 1 female) in the BNHS collection. These were collected by Maj. H.J. Walton from Peking (ACC No. 20824, 20825, 20826 with collection place as China Peking?). The identification was confirmed by J.C. Daniel, Curator of BNHS.

This is the first record of the occurence of this flycatcher in the Indian subcontinent.

I hope the birdwatchers visiting Melghat and the surrounding areas will keep a look out for this bird during winter to check whether it was an accidental visitor, which had lost its bearings during winter migration and landed in Melghat, or a regular winter visitor to this area which had escaped the notice of earlier birdwatchers.

I wish to thank S.A. Hussain and V.C. Ambedkar for very helpful discussions and assistance in identifying the bird. I also thank J.C. Daniel for going through my field notes and photographs and confirming the identification.

October 16, 1989 MEENA HARIBAL

REFERENCES

ALI, S. & RIPLEY S.D. (1983): A Pictorial Guide to the Birds of the Indian Subcontinent. Bombay Natural History

Society, Bombay.

KING, B., WOODCOCK, M. & DICKINSON, E.C. (1978): A Field Guide to the Birds of South-East Asia. Collins, London (Reprint). Pl. 85.

DEIGNAN, M.G. (1945): The Birds of Northern Thailand. Smithsonian Institution, United States National Museum Bulletin 186.

DEMENTIEV, G.P. & GLADKOV, N.M. (1968): The Birds of Soviet-Union (Ptitsy Sovetskogo Soyuza) Vol. VI. Israel Program for Scientific Translations, Jerusalem. p. 133.

FLINT, V.E. *et al.* (1984): A Field Guide to the Birds of USSR including Eastern Europe and Central Asia. Princeton University Press, London. p. 258, Pl. 30.

MAYER, R. DE SCHAUENSEE (1984): The Birds of China. Smithsonian Institution Press, Washington D.C. pl. 28.

25. FROG AND LIZARD IN THE DIETARY OF THE INDIAN ROBIN *SAXICOLOIDES FULICATA* (LINN.)

In the Keoladeo National Park on 15 July 1989, an Indian robin *Saxicoloides fulicata* alighted on the ground *c.* 25 m from me and caught an olive-green-and-white animal from the nearby drying water body. Careful observation through binoculars revealed it to be a small frog. The robin had caught the head end of the prey and battered it repeatedly as is done by a kingfisher. Occasionally the bird screeched as if it found difficulty in tackling the unusual prey. The frog appeared to be dead after eight minutes of struggle and the bird flew off with it to the adjacent old building where it had a nest. After the departure of the adult robin from its nest I checked the nest and could see only three nestlings. The ability of the Indian robin to kill a frog presumably to feed its young was something which was not expected.

A few days later, an Indian robin fed on a hitherto unrecorded food item. An adult robin repeatedly swooped on the wall where the nest was located. Close observation revealed the presence of a house gecko (*Hemidactylus* sp.) at the place where it swooped. At every swoop the robin hit the gecko, perhaps attempting to pull the lizard off the wall. As soon as the gecko fell to the ground, the bird battered the prey and tore its abdomen. The contents were eaten, after which it started devouring the lizard. Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) reported insects and their larvae, grasshoppers, ants, termites and hymenopterans as the food of the Indian robin. I could not find any herpetofauna in the dietary of the Indian robin in the available literature.

January 16, 1990 C. SIVASUBRAMANIAN

26. NEST SITE SELECTION BY BAYA *PLOCEUS PHILIPPINUS* (LINN.)

The baya *Ploceus philippinus* is generally a colonial nester. However, during a visit to Sarai village in Satna district of Madhya Pradesh I observed *Acacia arabica* Willd. trees growing in farm bunds in the vicinity of human habitation, bearing single baya nests. Out of 31 nest trees, 27 trees were with a single nest, one with two nests and three trees with four, seven and 19 nests. The minimum distance between the nest trees was 12 m and the maximum distance approximately 2 km. Height of the single nest-bearing trees ranged from 4.2 m to 11 m. As crown width ranged between 3 m to 7 m, the tree crowns were otherwise suitable for colonial nesting.

Construction of a single nest in the trees of any locality by the baya is an interesting phenomenon and hence worth placing on record.

November 2, 1989 DEEP NARAYAN PANDEY

27. BLACKHEADED MUNIA *LONCHURA MALACCA* (LINN.) IN GUJARAT

The blackheaded munia *Lonchura malacca* has been reported from Raipur, Pachmari, Bombay to Kanyakumari (Ali and Ripley 1983); Ali (1954) did not come across the bird in Gujarat. In this decade, however, it has been reported to occur in small numbers and flocks from different parts of the state — in Bhuj, Kutch district by Varu (pers. comm.); in Dabhoi, Baroda district by Monga and Naoroji (1983); in Jasdan, Rajkot district by Shivrajkumar (1985); in Anand, Kheda district by Parasharya and Patel (1985).

All these sightings have been interpreted as of escapees from captivity, though there has been no evidence for or against this view. The biggest flock observed so far constituted 20 birds feeding on sorghum crop (Parasharya and Patel 1985).

Recently near the Pariej reservoir on 13 September 1989, six pairs of the blackheaded munia were seen nesting on *Typha*. This is the first time the munia was seen breeding in Gujarat. The nests were barely visible from outside. We could locate the nesting site only because one bird was seen taking nest material. The nests, made of reeds and grasses in a ball form with an entrance on one side, were constructed halfway up the stem of the plants. All of them were built in a small patch of *Typha* covering an area of about 15 sq. m. Four nests had eggs in them, the number of eggs being 2, 3, 4 and 6. In one other nest, there were three hatchlings and one egg, whereas in still another one there were three 4-5 day old nestlings. Many more pairs might have been breeding there, but we did not have enough time to check the whole area. Soon thereafter, on two occasions in the same month, we observed two pairs, one each on *Typha* at Dethli (Kheda district) and in a sugar-cane field at Kodinar (Amreli district).

It is evident from the data presented that the munia has an almost state wide distribution in small numbers and very much limited to specific localities. Presently, we have information on its breeding only from Pariej, Kheda district, but it presumably breeds in other districts also.

With an increasing number of sightings of the blackheaded munia as well as the present report of a breeding colony, the bird seems to have well established wild populations in many parts of the state and must find a place in the checklist of birds of Gujarat as a resident bird.

We are grateful to the ICAR for financial support.

K.L. MATHEW
B.M. PARASHARYA
November 21, 1989 D.N. YADAV

REFERENCES

ALI, S. (1954): The birds of Gujarat, Part II. *J. Bombay nat. Hist. Soc. 52:* 735-802.

ALI, S. & RIPLEY, S.D. (1983): Handbook of the Birds of India and Pakistan (Compact edition). Oxford University Press, Delhi.

MONGA, S.G. & NAOROJI, R.K. (1983): Birds of the Rajpipla forests, South Gujarat. *J. Bombay nat. Hist. Soc. 80:* 575-612.

PARASHARYA, B.M. & PATEL, R.C. (1985): A new distributional range of blackheaded munia *Lonchura malacca. Pavo 23 (1 &2):* 105-106.

SHIVRAJKUMAR, K. (1985): Blackheaded Munia, *Lonchura malacca* in Jasdan, Gujarat. *J. Bombay nat. Hist. Soc. 82 (1):* 298-309.

28. COMMON GARDEN LIZARD *CALOTES VERSICOLOR* PREYING ON BROOK'S GECKO *HEMIDACTYLUS BROOKI*

The food habits of the common garden lizard *Calotes versicolor* (Daudin) have been described by J.C. Daniel (THE BOOK OF INDIAN REPTILES, 1983). According to him it prefers insects but occasionally may feed on small birds, nestlings, frogs and other small animals. S.K. Sharma (*JBNHS 88(2):* 290-291) has recorded this species feeding on its own young ones also.

On 26 April 1991, at about 1200 hrs, I observed an adult common garden lizard on the trunk of an *Albizzia lebbeck* tree in the World Forestry Arboretum, Jaipur, which was swallowing a sub-adult Brook's gecko *Hemidactylus brooki* Gray. The head of the prey was in the mouth of the predator and the helpless gecko was wagging its tail. Its hind legs were also in motion in an effort to escape. Despite all the efforts made by gecko, within eight minutes the process of swallowing was completed.

The common garden lizard and Brook's gecko both live on trunks of trees in the Arboretum. Both are insectivorous and seem to be competitors for food, but the garden lizard is at an advantage as its feeding area is not limited to tree trunks, but also extends to the ground in the vicinity. By preying geckos, the common garden lizards reduces competition and also gets a substantial meal.

May 23, 1989 SATISH KUMAR SHARMA

29. SNAKE BITE : AN EXPERIENCE

Denkanikota, a small town on the Mysore plateau 64 km from Bangalore, is the base of my study on the ecology of elephants inhabiting highly degraded dry deciduous and thorn forest in the Hosur and Dharmapuri forest divisions of Tamil Nadu. On the evening of 9 July 1989, I parked my motor cycle as usual in the compound of the Forest Rest House and walked along the footpath to my quarters. It was dark and raining heavily. Suddenly I felt a sharp, stinging bite on my leg. I jerked my leg back. As the snake coiled around my ankle, I shouted to the man walking ahead of me with a torch to shine the light on my leg so that I could identify the snake. When we saw the black and white rings of the snake he screamed Mandalam (krait) and ran away. I shook off the snake and ran to my house. Hearing the commotion, my neighbour and my servant had come out to the path. Telling them that I was going to the hospital, I rushed back to my bike and drove into the town. On the way, I remembered an incident that had happened when I was 14 years old (1977), I had seen a man who was collecting paddy straw in the field being bitten four times by a cobra when he was trying to shake off the snake coiled around his leg. By the time we could call people from the neighbouring fields to help us take him to the hospital, he died (within an hour). While remembering this I realised that I had forgotten to put a tourniquet on my leg.

It was 2045 hrs when the first doctor I went to, refused to open the door. I was more fortunate with the Government doctor, who asked me to get myself admitted in the hospital 2 km away and said she would follow as soon as she could contact her husband for transport to the hospital. She phoned ahead to the hospital to have me admitted in the emergency ward. I drove to the hospital and it was 2105 hrs by the time I arrived. By now I could feel the poison moving up my leg, a prickly, electric shock-like, painful tingling from my bitten heel to my upper thigh. I was immediately put on drip and given an injection of Decadran. The doctor arrived 20 minutes later. My eyesight was blurring. I was now semi-conscious, that is I could hear what was happening around me but in a detached manner. The doctor first gave me a test dose of polyvalent antivenom and after a brief observation she gave three vials of polyvalent antivenom intravenously and stayed with me from 10.30 at night to 4.00 the next morning when I became fully conscious again.

I had been in a semi-comatose state and my field assistants who sat with me were frightened of letting me fall asleep and kept shaking me awake whenever they thought I was dozing off. My temperature shot upto 104°F and my nails become blackish blue. After an analgesic injection for the fever I was sent home the next morning largely due to the pressure for beds in the small hospital.

36 hours after the bite I suddenly developed severe spasms in the intercostal chest muscles, and had difficulty in breathing. I was rushed back to the hospital and given antispasmodic injection. The spasm disappeared after one and a half hours.

The next day and for 21 days thereafter I developed high fever accompanied by a severe headache every afternoon. Even now I get pain in my joints occasionally, but no other symptoms.

PRECIS OF CASE

Date and time of bite	:	9 July 1989, 8.35 p.m.
Species of snake	:	Common krait *(Bungarus caeruleus)*.
First aid	:	Nil.
Time of admission in hospital	:	2105 hrs.
Symptoms	:	
Soon after snake bite	:	Electric shock-like painful tingling moving up the leg.
9.30 p.m. 10 July '89,	:	Blurred vision and semi-conscious.
4.30 a.m. 11 July '89	:	Full consciousness regained.
11 July '89	:	Severe spasms in the intercostal chest muscles.
9.00 a.m. 11-30 July '89	:	High fever with severe headache, during the hottest part of the day.
Treatment:		
9th July '89, 9.05 p.m.	:	Drip with decadran, IV.
9.30 p.m.	:	Test dose of polyvalent antivenom serum given.
9.40 p.m.	:	No symptoms of allergy.
Between 9.40 p.m. & 1.35 a.m.	:	3 vials of polyvalent antivenom serum given IV.
10th July '89, 6.00 a.m.	:	Analgesic injection.
11th July '89, 9.30 a.m.	:	Antispasmodic injection (Name of the injection not disclosed).
Post bite	:	Severe joint pains on occasion.

April 30, 1991

S. RAMESH KUMAR

30. ON THE OCCURRENCE OF *SAURIDA ISARANKURAI* SHINDO AND YAMADA 1972 FROM THE WEST COAST OF INDIA

(With a text-figure)

A total of eight species of the genus *Saurida* Val. 1849, viz., *Saurida tumbil* (Bloch, 1795), *Saurida gracilis* Quoy and Gaimard, 1824; *Saurida undosquamis* (Richardson, 1848), *Saurida longimanus* Norman, 1939; *Saurida micropectoralis* Shindo and Yamada 1972, *Saurida wanieso* Shindo and Yamada, 1972, *Saurida isarankurai* Shindo and Yamada, 1972 and *Saurida pseudotumbil* Dutt and Vidya Sagar, 1981 are known to occur in the seas around India (Day 1877, Munro 1955, Norman 1935, Rao 1977, Dutt and Vidya Sagar 1981, Nanda and Ramamoorthi 1982, Fischer and Whitehead 1974, Waples 1983). Dutt and Vidya Sagar (1981) reported *S. isarankurai* from India on the basis of material from Visakhapatnam and Kakinada, but did not provide any description. Later Nanda and Ramamoorthi (1982) reported this species again as a new record from India on the basis of one specimen from Porto Novo. While studying the taxonomy and biology of lizardfishes from the west coast of India, we collected several specimens of *S. isarankurai*. As there is no earlier report from the western Indian Ocean and alo due to the fact that there is no detailed description of the species based on adequate samples, it was felt necessary to provide information to understand the intraspecific variations if any, and also for easier identification of the species.

Specimens were collected from the catches of trawlers operating at a depth of 20-25 m off Mangalore, Malpe, Bhatkal and Karwar on the mid-west coast of India. Morphometric and meristic data were recorded following Hubbs and Lagler (1958). Colour was noted from fresh specimens. Standard length (SL) was measured from tip of snout to the end of vertebral column. A total of 24 morphometric characters and 8 meristic characters were recorded. The different body proportions were expressed in percentage of SL or head length along with their range and mean to facilitate better comparison.

Material examined: 31 males of length range 55-101 mm (SL) and 22 females of 51-116 mm.

Description: B. 14-15 (14); D. 11-13 (12); A. 10-12 (11); P1. 12-13 (13); P2. 9; L1. 45-49 (47); L tr. 4-5/6; Vertebrae 45-47 (45.5).

As percentage of standard length: Head length 22.4-25.5 (23.8): snout length 4.5-6.0 (5.2); eye diameter 4.1-5.8 (4.9); interorbital distance 3.3-5.2

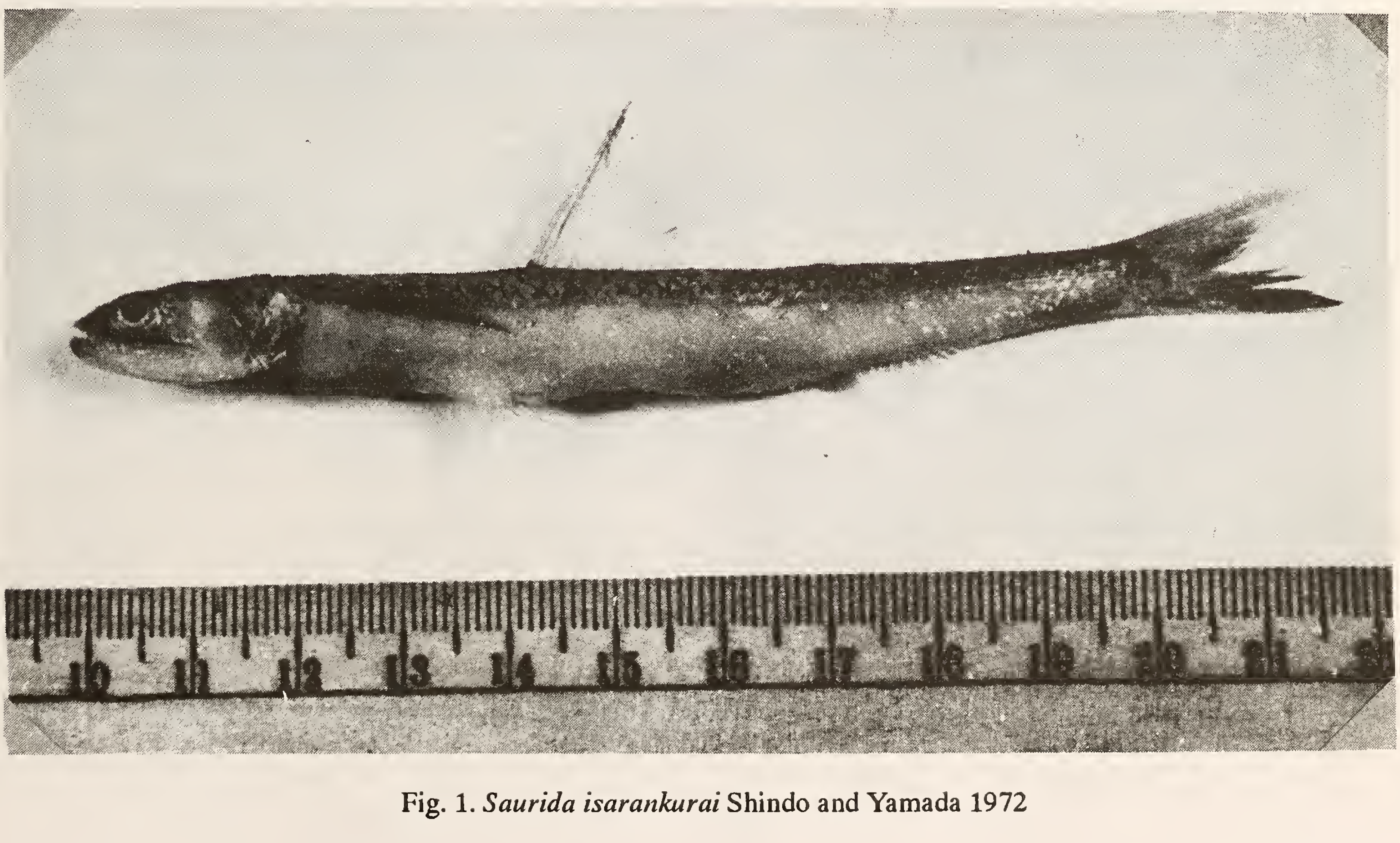

Fig. 1. *Saurida isarankurai* Shindo and Yamada 1972

(4.1); post-orbital length 12.8-14.9 (13.8); premaxillary length 13.8-17.4 (15.7). Distance from snout tip to origin of dorsal fin 41.5-48.6 (44.5); anal fin 71.8-79.7 (74.9); adipose fin 77.6-85.5 (82.0); pectoral fin 22.2-28.1 (25.7); pelvic fin 35.4-42.0 (39.2). Greatest body depth 10.5-13.3 (11.9); depth at pelvic fin origin 8.8-13.0 (11.2); depth at anal fin origin 8.5-11.7 (10.1); depth at caudal peduncle 5.8-7.4 (6.6). Height of dorsal fin 20.5-25.6 (22.9); dorsal base 11.8-14.4 (13.3); pectoral length 15.8-20.8 (18.3); pelvic length 15.0-19.1 (16.8); anal height 11.6-15.2 (13.0); anal base 8.4-13.3 (10.4); length of upper caudal lobe 17.9-23.6 (20.6). Distance from dorsal fin origin to adipose fin origin 29.6-40.6 (37.5); pelvic fin origin to anal fin origin 32.2-38.0 (36.0).

As percentage of head length: Snout 20.0-25.5 (22.0); eye diameter 17.0-23.8 (20.7); interorbital distance 13.5-21.8 (17.3); post-orbital length 53.1-60.6 (56.6); premaxillary length 60.6-72.2 (66.2); pectoral length 65.4-87.3 (77.1); pelvic fin length 63.6-80.0 (71.1).

Body elongate and cylindrical, head depressed. Lower jaw longer than upper jaw and visible from above when mouth is closed. Caniniform teeth in several rows in both jaws; palatine teeth caniniform in two narrow bands on each side, the inner band shorter than the outer. Second dorsal ray longest and equals head length. Pectoral tip extending well beyond origin of pelvic. Adipose dorsal fin above posterior portion of anal. Lower caudal lobe longer than upper lobe.

Colour: Dorsal side and upper flanks brownish mottled with grey, lower flanks and belly silvery white. A row of 8-10 indistinct dark spots along sides. Dorsal fin brownish yellow with scattered black pigments; its anterior upper corner dark. Upper part of pectoral fin dark, lower part white. Upper lobe of caudal yellowish with black pigment spots, lower lobe blackish, pelvic and anal fins without markings.

Distribution: West Central Pacific, coasts of India through Gulf of Thailand.

S. isarankurai forms a minor fishery during November to May along the Karnataka coast. It constitutes one of the components of the trawler catches operated at a depth of 20-50 m, comprising Squilla, crabs, juvenile nemipterids, *Upeneus* spp., *Platycephalus* spp. etc. Their catch per boat varied from 2 to 40 kg during November-May at Mangalore, Malpe, Bhatkal and Karwar.

S. isarankurai can be easily distinguished from other known Indian *Saurida* spp. by longer lower jaw visible from above when mouth is closed, longer pectoral fin extending beyond pelvic origin and reaching almost base of dorsal fin origin and longer lower lobe of caudal than upper lobe.

The present description of *S. isarankurai* from the west coast of India fully agrees with the same species from Gulf of Thailand originally described by Shindo and Yamada (1972) except the difference in the length of pectoral fin. In the present observation the pectoral length is 18.3% of SL instead of 19.1-23.8% as recorded by Shindo and Yamada. The pectoral fin length of 18.2% of SL as given by Nanda and Ramamoorthi (1982) for Porto Novo specimen is identical with the present observation. This indicates that specimens of *S. isarankurai* from Indian waters have slightly shorter pectoral fin than those from the Gulf of Thailand.

ACKNOWLEDGEMENTS

We thank Dr V.S.R. Murty, Senior Scientist, C.M.F.R. Institute, Kakinada and Dr N. Jayabalan, Assistant Professor, College of Fisheries, Mangalore for their valuable suggestions.

C. MUTHIAH
August 7, 1991 B. NEELAKANTAN

REFERENCES

Block, M.E. (1795): *Naturgeschichte der auslandischen Fische 9:* 112, pl. 430 (type locality: Malabar).

Day, F. (1875-1878): The Fishes of India. London.

Dutt, S. & Vidya Sagar, J. (1981): *Saurida pseudotumbil* - A new species of Lizardfish (Teleostei: Synodidae) from Indian coastal waters. *Proc. Indian natn. Sci. Acad.* B 47 (6): 845-851.

Fischer, W. & Whitehead, P.J. (eds.) (1974): FAO species identification sheets for fishery purposes. Eastern Indian Ocean (fishing area 57) and Western Central Pacific (fishing area 71) (FAO: Rome) Vol. IV.

Hubbs, C.L. & Lagler, K.F. (1958): Fishes of the Great Lakes Region. *Bulletin of the Cranbrook Institute of Science 26:* 1-218.

Munro, I.S.R. (1955): The marine and fresh water fishes of Ceylon. Dept. of External Affairs, Canberra.

Nanda, R.R. & Ramamoorthi, K. (1982): *Saurida isarankurai* Shindo & Yamada, Pisces: Synodidae: A new record from India. *Matsya 8:* 67-68.

Norman, J.R. (1935): A revision of the lizardfishes of the

genera *Synodus*, *Trachinocephalus* and *Saurida*. *Proc. Zool. Soc. London* 1935: 99-135.

Norman, J.R. (1939): Fishes. The John Murray Expedition, 1933-34. *Scientific Reps. 7:* 23-24.

Quoy, J.R.C. & Gaimard, P. (1824): Voyage autour du monde .... execute sur les corvettes de S.M. "L' Uranie" et" La Physicienne' pendant les annees 1817-20. Poissons. Pillet Ame, Paris.

Rao, K.V.S. (1977): Systematics and comparative osteology of Indian Lizardfishes (*Saurida* spp.). *Indian J. Fish 24:* 143-171.

Richardson, J. (1848): Zool. 'Erebus' and 'Terror', Fish. p. 138, pl. li. figs. 1-6.

Shindo, S. & Yamada U. (1972): Descriptions of three new species of the lizardfish genus *Saurida*, with a key to its Indo-Pacific species. *Uo 11*: 1-13, *12:* 1-14.

Valenciennes, A. (1849): *Hist. Nat. Poiss.* 22: 499 (type: *Salmo tumbil* Bloch).

Waples, R.S. (1983): Synodontidae. *In:* Fischer, W. and Bianchi (eds). FAO species identification sheets for fishery purposes. Western Indian Ocean (fishing area 51) (FAO: Rome) Vol. IV.

31. RECORD OF NEW LARVAL PARASITOIDS OF *LYMANTRIA BEATRIX* STOLL. (LEPIDOPTERA: LYMANTRIDAE)

Y.P. Singh (1982, *Punjab Hort. J. 22:* 113-114) observed mango *Mangifera indica* orchards being infested by *Lymantria beatrix* Stoll. in Saharanpur district of Uttar Pradesh. The present study was undertaken during September-October 1988 to find out the parasitoids associated with this pest. 100 larvae were collected from the infested orchard and kept for rearing under laboratory conditions. Each larva was kept in a glass vial and was provided with fresh tender leaves of mango as food. Four larval parasitoids were observed, viz. *Echthromorpha wotulatoria* Fabr. (3%), *Ephialtes instagator* var. *poesia* Cam. (5%), *Carcelia kockiana* Tours. (9%) and *Carcelia octava* Bam. (7%).

We thank Dr Pratap Singh, Forest Entomologist, F.R.I., Dehra Dun, for identifying the parasitoids.

Y.P. SINGH
November 19, 1990 V. KUMAR

32. SOME BUTTERFLIES OF NARCONDAM ISLAND (ANDAMAN)

The butterflies of the Andaman & Nicobar islands were studied in detail by Ferrar (*JBNHS 47:* 470-491, 1948). Subsequently I published a note (*JBNHS 79:* 702-704) on the butterflies of the Andaman Islands. Ferrar stated that certain areas in the Andamans remained to be completely or partially worked and in the former he had included the Narcondam island. Ferrar further writes "Narcondam and Barren Islands lie some 60 miles to the east of Great Andaman. The former with its unique Hornbill may also possess some unique butterflies". Therefore, a small collection done by SAH in March-April 1972 during his survey of the Narcondam hornbill is significant. The specimens were identified as below:

Family : Danaidae

Tirumala limniace Cramer

Recorded by Ferrar from Nicobars, Great Cocos and Port Blair. A single specimen was collected near camp on 25 March 1972.

Family : Pieridae

Cepora nerissa lichenosa M.

Dry season form collected inside the undergrowth near camp on 19 March. Earlier recorded by SAH from Great Andaman.

Family : Nymphalidae

Cynthia erota pallida Stg.

Two specimens collected on the way to summit along a stream and two specimens near the camp on 26 March.

Family : Lycaenidae

Loxura atymnus prabha M.

A common butterfly of the island. A specimen was collected on 11 April 1972.

N. CHATURVEDI
August 6, 1991 S.A. HUSSAIN

33. *CYCLEA PELTATA* (LAM.) HOOK. F. AND THOMS., *VIOLA BETONICIFOLIA* J.E. SMITH AND *TEPHROSIA CANDIDA* (ROXB.) DC. — NEW RECORDS FOR ANDHRA PRADESH

During the floristic survey of Andhra Pradesh, we have collected three plants which, on critical examination, have been identified as *Cyclea peltata* (Lam.) Hook. f. & Thoms., *Viola betonicifolia* J.E. Smith and *Tephrosia candida* (Roxb.) DC. The occurrence of these taxa from Visakhapatnam district is recorded here as new additions to the flora of Andhra Pradesh. The citation, detailed description and distribution is given here for their easy identification. The specimens have been deposited in the Herbarium of the Department of Botany, Sri Krishnadevaraya University.

MENISPERMACEAE

Cyclea peltata (Lam.) Hook.f. & Thoms. Fl. Ind. 201. 1855 & in FBI 1: 101. 1872. p.p. Gamble 1:31(22). 1915. *Menispermum peltatum* Lam. Encycl. 4: 96. 1797. *Cyclea burmanii* Hook. f. & Thomas. Fl. Ind. 201. 1855 & FBI 1: 104. 1872.

Twining pubescent herbs. Leaves cordate, 6-11 x 4-7 cm, coriaceous, 5-7-nerved, base truncate, margin entire, apex acuminate. Inflorescence a panicle, axillary, male flowers regular, female flowers irregular. Drupe obovoid, style scar sub-basal.

Rare in deciduous forests in Visakhapatnam district.

Flowers and fruits: Jan.-April.

Araku valley (Visakhapatnam district), *TP & EC* 7337.

Gamble (1915) reported its occurrence in the Western Ghats, hills of Mysore and North Arcot. Its occurrence in Visakhapatnam district in Andhra Pradesh extends its distribution to the Eastern Ghats also.

VIOLACEAE

Viola betonicifolia J.E. Smith in Rees, Cyclop. 37. n. 7. 1817. ssp. *betonicifolia* Jacobs & Moore in Steenis, Fl. Malesiana ser. 1. 7: 203. 1972. *Viola patrinii* DC. var. *napaulensis* DC. prodr. 1:293. 1824. *Viola patrinii* auct. non Ging. 1824; FBI 1: 183. 1872; Gamble 1: 48 (35). 1915.

Herbs, up to 10 cm, rootstock woody; stolons nil. Stipules nearly entire, 7.5 mm; petiole 4-9 cm long, winged; blade longer than broad, oblong or lanceolate, 3.5-6 x 1.5-2.2 cm, glabrous, base hastate, margin crenate to serrate, tip slightly obtuse or acute. Peduncle 12-15 cm long; bracteoles 2, near the middle peduncle or above it. Flowers white with pink striations; calyx 3 mm, sepals 5, lanceolate, petals 5, violet, upper pair 1.2 x 0.5 cm; lateral pair 1.3 x 0.5 cm; lower one (lip) 1.5 x 0.5 cm, apex obtuse, ovary oblong or ovoid, style truncate; stigma terminal, faintly 3-lobed, capsule 8 x 4 cm.

Rare in hills of Visakhapatnam district.

Flowers and fruits: July-Dec.

Anjodigadda (Visakhapatnam district) *TP & EC* 7437.

S.P. Banerjee and B.B. Pramanik in their 'Fascicles of Flora of India, fascicle no. 12 on Violaceae did not report its occurrence from Andhra Pradesh. Gamble (1915) reported its occurrence from Mahendragiri hill in Orissa. There is not even a single sheet either in MH, CAL or DD from Andhra Pradesh. So it is considered as a new report to the state.

FABACEAE

Tephrosia candida (Roxb.) DC. Prodr. 2: 249. 1825; FBI 2: 111. 1876. *Robinia candida* Roxb. Fl. Ind. 3: 327. 1832. (Fig. 1).

Erect shrubs with grooved woolly branches, leaves up to 15 cm, leaflets 8-13 pairs, oblong-elliptic, 5-8 x 1 cm, chartaceous, rusty above, woolly below, base cuneate, margin entire, apex obtuse. Flowers red or white, 15-30 cm long, axillary, pseudoracemes or pseudopanicles. Pod linear, 6.5 x 0.8 cm, woolly, continuous within, apex slightly curved; seeds ellipsoid, compressed, 2.5 mm.

Rare in deciduous forests of Visakhapatnam district.

Flowers and fruits: June - September.

Anjodigadda-Araku (Visakhapatnam district, *TP & EC* 7437.

Gamble (1915) has not reported this taxon from Madras Presidency. It has been reported subsequently from Tamil Nadu (Nair and Henry 1983) and Karnataka (Saldanha 1984). The present report extends the distribution of this species northwards to Andhra Pradesh also.

References

Gamble, J.S. & Fischer, C.E.S. (1915-1935): Flora of the Presidency of Madras (Repr. ed. 1957). Calcutta.

Nair, N.C & Henry, A.N. (1983): Flora of Tamil Nadu, India. Series I: Analysis. Coimbatore.

Saldanha, C.J. (1984): Flora of Karnataka. New Delhi.

T. PULLAIAH
E. CHENNAIAH

January 30, 1991

34. *STYLIDIUM TENELLUM* SWARTZ (STYLIDIACEAE) — A NEW RECORD FOR SOUTH INDIA

The family Stylidiaceae is very closely related to Campanulaceae and Lobeliaceae (Backer and Brink 1963-65) and is of special phyletic interest because of the peculiar gynostemium. Its members are distinguished from other related families by reduction in stamen number, adnation of the stamen to style and the extrorse anthers. The family has five genera with about 150 species in tropical Asia, Australia, New Zealand and temperate South America. The genus *Stylidium* Swartz (1805) was conserved over *Candollea* Labill (1805) and since this is the type genus of the family, the name of the latter was changed from Candoleaceae to Stylidiaceae (Lawrence 1951). If *Donatia* Forst. of which the systematic position is not at all clear is included, four genera are confined to Australia, Tasmania, New Zealand and Magellan region of South America. *Stylidium* is almost entirely Australian but a few species occur in Malaysia, Sri Lanka and continental Asia (Hooker 1885). Two species of *Stylidium*, very similar to certain intra-tropical ones, were found by Koenig—*S. uliginosum* in Sri Lanka and *S. tenellum* in Malacca. Two additional species are encountered in Dr Wallich's Catalogue, *S. wightianum* from peninsular India and *S. kunthii* from Khasi hills, Silhet, showing as in many other instances, the spreading of species into congenial climates beyond what at first appeared the natural limits of an order (Royle 1970, Kanjilal 1939).

According to Babu (1977) there are two species of *Stylidium* (*S. tenellum* Sw. and *S. kunthii* Wall.) in India, confined to eastern India with one extending to sub-Himalayan tracts. Babu (loc. cit.) has collected *S. tenellum* from grassy localities in the sal *Shorea robusta* forest in Rajpur and has reported it to be rare. These two species have also been reported earlier from Bihar and Orissa (Haines 1921-1924); and *S. tenellum* var. *minima* Clarke from Chhotanagpur (Prain 1963).

We are reporting for the first time the occurrence of *S. tenellum* from south India and have collected the specimens from Devarayanadurga while carrying out floristic explorations in Tumkur district, Karnataka, since 1985. The description of the plant is given below:

Stylidium tenellum Sw. Mag. Ges. Naturf. Fr. Berlin 1: 51. t. 2 + 3, 1807 (non R. Br. 1810); Hook. f. F.B.I. 3: 420, 1885; Mildbraed, Pfreich. 35: 35. 1908; Ridley, Fl. Malay peninsula 2: 197. 1923; Haines, Botany of Bihar & Orissa part iv, 499. 1921-24; Sloot. Fl. Males. ser. 1. 4: 530. 1954; Babu, Herb. Fl. Dehra Dun, p. 291. 1977.

Very small slender herb, glabrous, branched, branches filiform, stems dark brown or copper brown; leaves mostly basal, alternate, basal leaves mostly spathulate or linear or ovate, 3-nerved, nerves visible only on the upper surface; flowers solitary, minute, sessile in the axils of leafy bracts, zygomorphic, epigynous; base of the flower glandular; sepals 5, linear, subequal, rotately spreading, persistent in the fruits, lower lobes fused to 1/4 length; corolla strongly bilabiate, two of them prominent and ray-like, lobes divided, corolla tube minute; stamens 2, filaments united into a column, column slightly bent to one side, anther lobes 4, all equal, syngenaceous, stigma hairy; ovary inferior, well developed; capsule linear, elongating in fruit, dehiscing along longitudinal sutures; seeds powdery, minute, surface light brown, smooth, more or less angled.

Coll.: V. Bhaskar and C.G. Kushalappa 1944, 20 October 1986; 2079a, 10 December 1987, Devarayanadurga, Tumkur dist., Karnataka (Figs. 1 and 2).

This delicate herb occurs in moist grassy places at the foot of the hill during rainy season. The plants are so inconspicuous in stature (5-8 cm) that one may miss them completely or mistake them for most common utricularias. *Rotala ilecebroides*, *Lindernia*, *Bergia*, *Canscora diffusa*, *Xyris*, *Commelina* and *Eriocaulon* form the other chief associates. However, they may be distinguished by their copper brown tinged stem, pink or rose coloured flowers and the peculiar gynostemium with 2 stamens connate with style and extrorse anthers

at summit of column and the inferior ovary. The column (or trigger) is a sensitive part moving elastically on touch to rest between labellum and posterior lobes before resetting. Hence these plants have been named trigger plants (Brickson 1958).

Stylidium tenellum was collected consecutively during 1986 and 1987 but only from a small patch in Devarayanadurga and was not found in any other location in the district. Considering the restricted occurrence in south India it would be interesting to study the dispersal mechanism and geographical distribution of these plants.

ACKNOWLEDGEMENT

We are grateful to the Botanical Survey of India for providing financial assistance to carry out the floristic study of Tumkur district from 1985-1988.

V. BHASKAR
C.G. KUSHALAPPA

January 7, 1991

REFERENCES

Babu, C.R. (1977): Herbaceous flora of Dehra Dun. CSIR, New Delhi.

Backer, C.A. & Brink, R.C. Bakhuisen van den (1963-65): Flora of Java, 2:453. Groningen.

Brickson, R. (1958): Trigger plants. Paterson Brokensha Pty. Ltd., Perth.

Haines, H.H. (1921-24): Botany of Bihar and Orissa. Part iv. London.

Hooker, J.D. (1885): Flora of British India 3: 420. London.

Kanjilal, U.N., Das, A., Kanjilal, P.C. & De, R.N. (1939): Flora of Assam 3: 127. Govt. of Assam.

Lawrence, H.M.G. (1951): Taxonomy of vascular plants, p. 724. Macmillan Co., New York.

Prain, D. (1963): Bengal plants 1: 465. B.S.I., Calcutta.

Ridley, H.N. (1923): The flora of Malay peninsula 2: 197. London.

Royle, F. (1970 rep. ed.): Illustration of botany of the Himalayan mountains, p. 254. New Delhi.

35. *PARTHENIUM HYSTEROPHORUS* LINN. — A NEW RECORD FOR NEPAL

On the way to Kathmandu from Birganj in July 1989, I located an American weed, *Parthenium hysterophorus* Linn., a member of the family Compositae, growing on either side of the road. Subsequently, I collected this weed from Kathmandu proper. On critical examination of the available literature on the flora of Nepal (including Flora of Kathmandu Valley, 1986), it was found to be a new record for the flora of Nepal.

It is probably a migrant from India. A number of publications and discussions have already been made on its introduction and occurrence in India. The recent two review articles by Bennet *et al.* (1978, *Indian J. Forest 1:* 128-131) and Naskar and Guha Bakshi (1985, *J. Econ. Tax. Bot. 7:* 741-748) may be referred for further details.

The specimens of *P. hysterophorus* collected from Kathmandu have been housed in the Herbarium of Post Graduate Centre of Botany, Gaya College, Gaya. This is the first report of its occurrence in Nepal. A short description, citation, distribution, toxic effects, phenology, common names of this taxon have been given below to facilitate easy identification.

Parthenium hysterophorus Linn., Sp. Pl. 988. 1753; Hill, Veget. Syst. 3: t. 21.1761; Hoffmann in Engler & Prantl, Nat. Pfam. 4 (5): 114. 1889; Rao, J. Bombay nat. Hist. Soc. 54: 218. 1956; Reed, Phytologia 10: 338. 1964; Mahesh., Curr. Sci. 35 (7): 181.1966; Vaid & Naithani, Ind. For. 96 (10): 791. 1970; Adams, Fl. Pl. Jamaica 751. 1972.

An erect, profusely branched herb, up to 1.5 m tall. Stems longitudinally grooved, angular, hairy. Leaves alternate, 2-10 cm long and up to 5 cm broad, pinnately or bipinnately dissected; segments linear, entire, pubescent, acute; smaller and undivided in the region of inflorescence. Heads many-peduncled, in panicles, radiate, heterogamous. Involucral bracts biseriate; outer bracts 5, ovate, acute, prominently nerved; inner bracts 5, obovate, transparent, subtending a female floret with two male florets on either side. Receptacle flat, paleaceous. Outer florets: 5, female; inner few male. Female florets: jug-shaped, white; corolla cup-shaped with indistinct lobes enclosing style; stigma bifurcated. Inner florets: all male, yellowish; corolla infundibuliform; stamens exerted. Achenes obovate, black, crowned by persistent remnants of corolla, appendages and styles; pappus of 2 awns.

Distribution: A native of tropical America, from Florida to Texas. It has also been collected from the

West Indies and some parts of South Africa. In India, the species has now become naturalised not only in plains but has also invaded the hilly regions of Assam, Jammu and north-west Himalayas.

The weed causes allergic types of diseases such as asthma, fever and dermatitis and is dangerous to human beings and crops.

Common name: Congress grass, Gajar grass.
Flowering and fruiting: Practically all the year round but mostly from August to December.
Specimens examined: Kathmandu, *K.K. Mishra* 5010, 5011.

November 17, 1990 K.K. MISHRA

36. OCCURRENCE OF *CLERODENDRUM WALLICHII* MERR. (VERBENACEAE) IN SOUTH INDIA

(With a text-figure)

Fig. 1. *Clerodendrum wallichii* Merr.

During the course of botanical explorations in some parts of the Western Ghats, we collected an interesting species of *Clerodendrum* from Vythiri river banks, Wynad district, Kerala, namely *C. wallichii* Merr. A perusal of literature shows that it is distributed in the northern parts of India to Burma and often grown in gardens for its elegant pendulous inflorescence.

Clerodendrum wallichii Merr. in Journ. Arn. Arb. 33: 220, 1952; Backer Fl. Java 2: 611, 1965; D.B. Deb Fl. Trip. State 2: 109, 1983. *Clerodendrum nutans* Wall. *ex* D. Don Prodr. Fl. Nepal 103, 1825 *non* Jack 1820; Clarke in F.B.I. 4: 591, 1885.
Specimens examined: Wynad, Kerala, Pradeep 6036 (CALI).

We thank Prof. K.S. Manilal, Head of Department of Botany, University of Calicut, for providing necessary facilities.

February 19, 1990 A.K. PRADEEP K.M. JAYARAM

37. *DIDYMOCARPUS PYGMAEA* CLARKE (GESNERIACEAE) — A NEW RECORD FROM MAHARASHTRA

During frequent visits to various localities of Bhandara district (Maharashtra) I collected *Didymocarpus pygmaea* Clarke from Mahadev hills of Amgaon tehsil. This species has not been reported from Maharashtra (Cooke 1901-1908, Mahabale 1987) being known so far from Madhya Pradesh (Mukherjee 1984, Verma *et al.* 1985), Madras (Gamble 1957), Bihar and Orissa (Haines 1961). This paper records for the first time the occurrence of *Didymocarpus pygmaea* Clarke from Maharashtra. Voucher specimens are housed in the Herbarium, Department of Botany, Bhawbhuti Mahavidyalaya, Amgaon.

Didymocarpus pygmaea Clarke in Hook. f. Fl. Brit. Ind. 4: 345. 1884; D.C., Monogr. Phan. 5: 82. 1885; Duthie, Fl. Upp. Gang. Pl. B S I reprint 2(1): 168. 1960; Gamble, Fl. Pres. Madras B. S. I. reprint 2: 694, 1957; Haines, Bot. Bihar & Orissa B. S. I. reprint 2: 679, 1961.

Plants tiny herbs; stem 4 to 25 mm tall, slender, curved, bearing one leaf at its apex. Leaf elliptic-ovate, 2.5 x 2 cm or much smaller, oblique, obtuse at both ends, thin; petiole 0-2 mm long. Pedicels few, 5-8 mm long, tubular. Stamens two, fertile, two, linear rudiments, glabrous; anther cell two, ovate, oblique, scarcely

confluent by their tips. Ovary and style villous; stigma small, subcapitate, scarcely 2-lobed. Capsule 1.5-2 cm long, nearly straight, 2-valved. Seeds ellipsoid, small, smooth, minutely reticulate.

Flowers and fruits: August-September.

Occasional, in shade in rocky areas.

Specimen examined: Mahadev hills (Amgaon), 352.

I thank Dr V.N. Naik, Dept. of Botany, Marathwada University for the identification and for valuable suggestions; and S.R. Anjankar, Principal, for providing facilities.

March 9, 1991 S.M. BHUSKUTE

REFERENCES

COOKE, T. (1901-1908): The Flora of Bombay Presidency. 2 vols. London. (Reprint 3 vols. 1958, B.S.I., Howrah.)

MAHABALE, T.S. (1987): Botany and Flora of Maharashtra. *In:* Maharashtra State Gazetteers, General State Series, Botany - Part IV. Bombay. Ed. K.K. Chaudhari.

MUKHERJEE, A.K. (1984): Flora of Pachmarhi and Bori Reserves. B.S.I., Howrah.

VERMA, D.M., HANIF, M.I. & SARAN, R. (1985): Flora of Raipur, Durg and Rajnandgaon. B.S.I., Howrah.

38. DISTRIBUTION OF *GLOCHIDION HIRSUTUM* (ROXB.) VOIGT IN INDIA

(With a text-figure)

During a floristic expedition (1986 to 1990) in Sambalpur district, Orissa, a small population of a small tree was recorded from Pradhanpat falls (Deogarh), which is now identified as *Glochidion hirsutum* (Roxb.) Voigt of Euphorbiaceae. In the same area, another species, *G. zeylanicum* (Gaertn.) A. Juss was also found growing side by side.

Hooker (1887) recorded the distribution of *G. hirsutum* as "Sikkim, Terai and Assam to Chittagong and Penang (= Pinang)." He also noted that the species was introduced into the Indian Botanic garden "probably from China". Airy Shaw (1972) noted its distribution as "Eastern Himalaya to Hainan, Hong Kong and Formosa (= Taiwan)". In literature, the records of Indian distribution include North Bengal, duars, Sikkim, Andamans and Assam (Hooker 1887, Prain 1903, Kanjilal *et al.* 1940). At the herbarium CAL specimens from West Bengal, eastern Himalaya, Assam, Meghalaya, Arunachal, Tripura, Maharashtra, Karnataka and Andamans represent the Indian distribution. Specimens from West Bengal (and eastern Himalaya) are from Jaldaka valley (500-1000 m) and Dulka Jhar (Darjeeling), which represent the extremity of its distribution in eastern India as well as in south-east Asia.

Fig. 1. *Glochidion hirsutum* (Roxb.) Voight

A scrutiny of the climatic conditions of the areas of distribution of *G. hirsutum* shows that it grows in preferentially in thickly forested hilly regions, generally warm and humid habitat. The distribution is centred between the easternmost hilly tract of India and Malayan peninsula and then extends on both sides. Though no recently published flora in India recorded the species and the collection at CAL are also all old specimens, its occurrence in Darjeeling (eastern Himalaya) in north-eastern region and Malabar (Maharashtra and Karnataka) in the south-western region of India appears broadly discontinuous. Apparently, it shows a climatic disjunctive distribution, and its absence from the eastern coastal regions of the country as well as from Sri Lanka and Kerala remains

unexplained.

The habitat of *G. hirsutum* below Pradhanpat Falls in Sambalpur district is also within the deep forest and is situated almost on the same latitude (± 21°30'N) as are the places of its distribution in south-east Asia. The place also remains humid throughout the year.

The present record of the species from Orissa is probably another evidence of its discontinuous distribution. The species starts flowering at an early age and produces healthy seeds. Probably, the species migrated to Malabar through the hilly regions of West Bengal, Bihar, Orissa and Madhya Pradesh. It has now been eliminated from the path of its migration, most probably due to the prevailing dry climate of this region except in some very isolated pockets.

However, the present report is not only a new record for Orissa but also for the entire Gangetic plains and the broad central plateau of India.

C. hirsutum may be confused in the field with *G. zeylanicum* which is available almost in all the tropical and subtropical regions of India and can be easily distinguished by the following key:

Lamina tomentose beneath; capsule pubescent .... *G. hirsutum*.
Lamina glabrous beneath; capsules glabrous .... *G. zeylanicum*.

Being a rare and little known plant in the Indian subcontinent, a brief description is given below to help further exploration in the adjoining regions (Fig. 1):

Glochidion hirsutum (Roxb.) Voigt, Hort. Suburb. Calcutta 153. 1845; Muell.-Arg. in Linnaea 32 : 61. 1863; Hook. f. in Hook. f., Fl. Brit. India 5 : 311. 1887; Prain, Beng. Pl. 2 : 931. 1903; Parkinson, For. Fl. Andaman 235, 1921-22; Kanjilal *et al.* Fl. Assam 4: 184. 1940; Airy Shaw in Kew Bull. 26 : 275. 1972. *Bradleia hirsuta* Roxb., Fl. Ind. 3: 699. 1832.

Small tree up to 5 m high with watery latex; branches densely pubescent. Leaves simple, alternate; petiole ± 0.3 cm long, densely hairy; lamina broadly ovate or elliptic, ± 17.0 x 7.5 cm, entire, acuminate, base rounded or slightly cordate, oblique, rusty-tomentose beneath, often drying purplish-brown beneath, lateral nerves ± 10 pairs. Inflorescence usually very shortly pedunculate and supra-auxiliary, few-flowered. Petals 6 in both sexes, externally hirsute, glabrous within; anthers 6 in male flowers, connective short; ovary globose, hairy; style conical. Capsule subglobose, obscurely lobed, ends slightly depressed, ± 0.5 cm across, pubescent with persistent style and perianth.

Flowers and fruits: September to April

Specimen cited: Pradhanpat, Deogarh, 23 January 1989, *Das et Panda 1350* (CAL)

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We thank the Director, Botanical Survey of India for access to its herbarium (CAL) and library and also for providing a research fellowship to one of us (S.P.). We are also thankful to Prof. S. Chanda and Dr T. Chakraborty for going through the manuscript and for their suggestions.

SAURIS PANDA
A.P. DAS

October 22, 1990

REFERENCES

AIRY SHAW, H.K. (1972): The Euphorbiaceae of Siam. *Kew Bull. 26:* 275.

HOOKER, J.D. (1887): The flora of British India *5:* 311. London.

KANJILAL, U.N., KANJILAL, P.C., DE, R.N. & DAS, A. (1940): Flora of Assam *4*: 184. Calcutta.

PRAIN, D. (1903): Bengal Plants *2:* 931. Calcutta.

39. THE OCCURRENCE OF *PHALAENOPSIS CORNU-CERVI* (ORCHIDACEAE) IN ANDAMAN AND NICOBAR ISLANDS

Phalaenopsis cornu-cervi (Breda) Bl. & Reichb. f. was described by Breda under the genus *Polychilos.* However, Blume and Reichenbach (1860) recognised that it is better placed under *Phalaenopsis* Bl.

Kurz (1876) reported this species as occurring in the tropical forests of Kamorta island. Sweet (1980) gave the world distribution of this species as Sarawak, Borneo, Java, Sumatra, Thailand, Malaysia, India based on Kurz's collection from Nicobar Island and Burma. Vasudeva Rao (1986) does not include this species in his list. Karthikeyan *et al.* (1989) gave the distribution of this species in India as eastern Himalaya and north-east India.

The plant has not been collected again in Andaman and Nicobar islands since its report by Kurz in 1876 from Nicobar island. It is to be noted that Nicobar group of islands have more species common with Indonesia in the south and Malaysia in the east.

Recently this species has been collected from Entrance Island (North Andamans) thus extending its distribution in Andaman islands; many species are common to north-east India, Burma and Thailand.

Phalaenopsis cornu-cervi can be easily recognised by the inflorescence with its terete, basally tapering peduncle and its laterally compressed, flexuous, complanate-alate rachis. A short account of the species is presented here for easy identification.

Phalaenopsis cornu-cervi (Breda) Bl. & Reichb. f. in Hamb. Gartenz. 16: 116. 1860; Kurz in J. As. Soc. Beng. 45(3): 156. 1876; Hook. f., Fl. Brit. India 6: 29. 1890; C.E. Fischer in Rec. Bot. Surv. India 12: 141. 1938; Sweet in Amer. Orch. Soc. Bull. 38: 512. 1969 & Genus *Phalaenopsis* 55. 1980; Karthik. *et al.*, Fl. Ind. Enum. Monocot. 163. 1989. *Polychilos cornu-cervi* Breda in Kuhl & Van Hasselt, Gen. & Sp. Orchid. t. 1.

Epiphytic; roots profusely produced from rhizome-like stem, fleshy, flexuous, glabrous; stem short, completely enclosed by imbricating leaf-sheaths. Leaves 2-4, 9-20 x 3.0-5.5 cm, fleshy, oblong-ligulate to oblong-oblanceolate, obtuse. Inflorescences 1- 2, 11.0-27.5 cm long; peduncle terete with 1 or 2 small cauline sheaths; rachis simple, laterally compressed, commonly many-flowered; bracts alternate, distichous, ovate-cucullate. Fruits *c.* 4.0 x 0.4 cm, linear, fruiting pedicel *c.* 0.5 cm long.

Illustration: J.J. Sm., Orch. Java. Fig. - Atlas pt. 5, fig. 415. 1912; Seidenfaden & Smitinand, Orch. Thailand 4: fig. 403. 1963 & Orch. Digest 36: 168. 1972; Katoh & Futakuchi, Orchids in Colour pl. 114, fig. 4. 1974.

Specimen examined: INDIA : North Andamans, Entrance Island, 8 November 1990, *P. Lakshminarasimhan* and *L.N. Ray* 15199 (PBL).

Ecology: Rare in the tropical inland forests.

We are thankful to Dr B.D. Sharma, Director, Botanical Survey of India, for facilities and to Dr J.L. Ellis, Deputy Director, Botanical Survey of India, Andaman and Nicobar Circle, Port Blair, for encouragement.

P. LAKSHMINARASIMHAN
L.N. RAY

January 30, 1991

REFERENCES

KARTHIKEYAN, S., JAIN, S.K., NAYAR, M.P. & SANJAPPA, M. (1989): Florae indicae enumeratio : Monocotyledonae. Botanical Survey of India, Calcutta.

KURZ, S. (1876): A sketch of the vegetation of the Nicobar Islands. *J. As. Soc. Beng. 45 (3):* 105-164.

SWEET, H.R. (1980): The Genus *Phalaenopsis.* The Orchid Digest Inc., U.S.A.

VASUDEVA RAO, M.K. (1986): A preliminary report on the Angiosperms of Andaman-Nicobar Islands. *J. Econ. Tax. Bot. 8(1):* 107-184.

40. INFESTATION OF *PARROTIOPSIS JACQEMONTIANA* BY *LEUCOMA SERICEA* (LYMANTRIIDAE) IN DACHIGAM NATIONAL PARK, KASHMIR

During a four month stay in Kashmir in 1989, cateripillars of *Leucoma sericea* (Lepidoptera: Lymantriidae) were observed infesting *Parrotiopsis jacquemontiana*. This is a perennial plant occuring on the slopes of Dachigam National Park and areas around it.

Inside the park boundary this plant is more abundant on the south and south-west facing slopes, besides covering a large chunk of the main Dachigam nalla.

The caterpillar is greyish yellow and the moth is white in colour; the latter was identified in the entomology section of Aligarh Muslim University. The caterpillar is a voracious feeder on leaves and the infestation reaches its peak in July, when most of the infested slopes look brown as almost all leaves are eaten up.

This plant is of vital importance for the conservation and management of the park. It provides excellent cover for the rare hangul *Cervus hanglu* and to various other fauna of the National Park.

February 21, 1990

SALIM JAVED

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